HEALTHY LIVING

WINSLOW

BOOK TWO

ENLARGED EDITION

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HEALTHY LIVING

BOOK TWO

PRINCIPLES OF PERSONAL AND COMMUNITY HYGIENE

BY

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ENLARGED EDITION

WITH A CHAPTER ON "SPORT AND HEALTH"

BY

WALTER CAMP

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PREFACE

Year by year the preservation of health becomes more and more a problem which requires the intelligent coöperation of the individual with the specialist. Physicians rely on personal hygiene or the conduct of the daily life rather than on drugs. Health departments are less interested in restrictive ordinances than in public health education. In order, however, that the teachings of the physician and the health officer may bear fruit, they must take root in a soil which has been thoroughly prepared for their reception. A sound fundamental knowledge of the principles of physiology and hygiene and sanitation thoroughly diffused through the community is essential to real progress in the future. It is in the schools that the basis must be laid, and this book has been prepared in the hope that it may be of some aid in laying it soundly.

In the portion of the book which deals with physiology and personal hygiene, the attempt has been made to eliminate all needless anatomical detail and to dwell on the working of the living machine with its wonderful complexities and correlations. Since the writer approaches the subject from the standpoint of a biologist interested primarily in public health, special stress has been laid on the relation of the living machine to its environment, and particularly to its microbic enemies. The marvellous achievements of public health science during the past decade make it important that every boy and girl should know something of the problems of municipal sanitation, of the campaigns against infant mortality and tuberculosis, and of the conquest of insect-borne disease on the Isthmus of Panama.

The attempt has been made throughout this book to make knowledge a basis for action and to focus the discussion upon such practical conduct of life as will conduce to the maintenance

of a maximum of personal vigor and to an alert coöperation in all community movements for the protection of the public health.

The author desires to acknowledge gratefully the assistance received from many persons in the criticism of the manuscript. In particular, thanks are due to Professor Percy G. Stiles of the Harvard Medical School, Dr. J. C. Greenway, director of the Department of University Health, Yale University, Dr. Gustav Ruediger, Health Commissioner of La Salle, Peru, and Oglesby, Illinois, and Dr. Fred Moore, Supervisor of Health and Hygiene in the public schools of Des Moines, Iowa, for physiological and medical criticisms; to Dr. Edwin C. Broome, Superintendent of Schools, East Orange, New Jersey, and Miss Laura S. Plummer, Head of the Department of Physical Education of the Normal School, Boston, Massachusetts, for assistance from a pedagogic standpoint. The author also expresses appreciation of the services rendered by Miss Gertrude K. Colby, assistant in the Department of Physical Education, Teachers College, Columbia University, in the preparation of the Questions following each chapter, and by Miss A. M. Thompson in the preparation of the Index.

A considerable proportion of the illustrations in the book, particularly in the chapters dealing with sanitation, have been copied from models, drawings, and photographs in the Hall of Public Health and other departments of the American Museum of Natural History, New York; acknowledgment is made particularly for permission to reproduce Figures 61, 62, 84, 85, 86, 87, 88, 92, 93, 94, 98, 99, 101, 102, 103, 104, 105, 106, 109, 111. Anatomical material, in the case of Figures 6, 9, 18, 64, was courteously loaned for photographing by Professor H. B. Ferris of the Yale Medical School.

The author also wishes to express grateful appreciation to the American Social Hygiene Association for permission to reproduce Figure 78, from *The Way Life Begins*, by B. C. and V. M. Cady, copyright, 1917, The American Social Hygiene Associa-

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CONTENTS

HEALTHY LIVING

CHAPTER I

THE LIVING MACHINE

Fig. 1.—A strong, healthy body makes play and work a delight.

The Living Machine.—Most of us are interested in machines and the wonderful things they do. A small child, given a new toy, will ask, "What does it do?" and his next question is very likely to be, "How does it do it?"

Boys and girls, and horses and dogs, are just as truly machines as steam engines or walking dolls. The machinery in a person or an animal is much more complicated, however, than the machinery in the steam engine, and a living being can do many things which no other kind of

machine has ever done. As we study the way in which the various parts of the body work together, we shall see more and more what a wonderful thing it is.

The Structure of the Living Machine: Organs and Systems of Organs.—The human body is made up of many **organs.** Each of these organs has its own special task. The hand, for instance, is the organ by which we grasp things; the eye is the organ by which we see; the heart is the organ which pumps the blood.

These organs are grouped into a small number of sets or **systems of organs.** The bones form one system, which gives strength and firmness and at the same time allows the body to move. The various muscles make up a system whose work it is to bring about this movement of the parts of the body. The system of organs of digestion prepares the food for use, and each of the other systems likewise performs its own important work.

Tissues.—The various organs and other parts of the body are made up of different kinds of living matter which we call **tissues.** The hand, for instance, has skin on the outside, and its central framework is made up of bone tissue. Fine threads of nerve tissue run out to all parts of the hand, and the muscles in it are made of still another kind of tissue.

Cells.—If we should look at any of these tissues under a strong microscope, we should find that it is built of tiny bits of living matter called **cells,** each having a denser structure in it called a **nucleus.** The cells are packed together like bricks in a wall to make a layer of skin tissue, or muscle tissue, or whatever the particular kind may be. The cells of each kind are different from all the others. Muscle and nerve cells are long and slender, blood

cells are flattened discs, and skin cells are like irregular blocks.

Protoplasm.—The living material of which the cells are made is called **protoplasm** (prō′ tō plăz'm). If you look at protoplasm under a micro-scope, you can see only a thick liquid with specks in it; but when you know something of the changes which go on in it, you will realize that protoplasm is the most remarkable substance in the world. When you move or see or think, it is because of chemical changes which are going on in the protoplasm of the muscle or nerve or other cells.

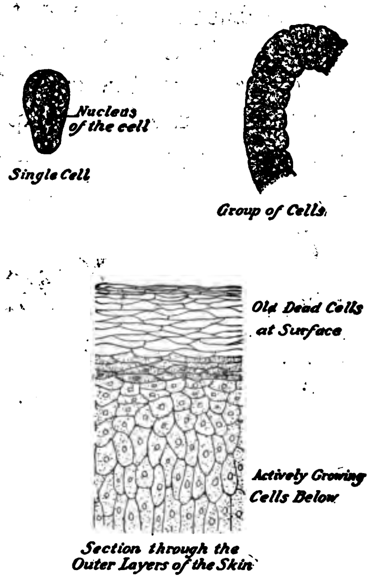

Fig. 2.—The building stones of the body.

Protoplasm contains a great deal of water and some minerals, and sometimes sugar and fat, but the chief thing that is always found in protoplasm is a kind of matter called **protein** (prō′ tē ĭn).

How the Cells Work Together.—The cells of the body may be compared to the people in a city. Some people do one kind of work and some another; one is a carpenter, another a motorman, another a banker. If the people are good citizens, the work of each one benefits the others. The carpenter makes furniture for the motorman and the banker; the motorman carries the banker to his office and

the carpenter to his shop; and the banker takes care of the carpenter's and the motorman's savings. Each one does the particular kind of work that he can do best, for the benefit of all the others.

Somewhat the same kind of thing is going on in the human machine. In a healthy body the cells of the different tissues are all good citizens. The stomach cells help to digest food which will build up the muscles, and the muscle cells move the jaws which chew the food so that the stomach

Fig. 3.—The human body is a machine which may, in many respects, be compared with a locomotive.

can digest it. All the millions of cells are working together in harmony for the common good.

Fuel for the Living Machine.—If any piece of machinery is to do the work for which it is intended, two very important things are necessary. First, there must be some force or energy to put the machine into motion and keep it working; and second, as parts of the machine wear out or become broken, they must be replaced.

In the case of a steam engine, the force or energy needed to run it is supplied by coal or oil, or some other fuel, which burns under the boiler and makes the heat that turns the water into expanding steam. In the case of our bodies, the energy needed to keep the different parts at work is supplied

by the food we eat. The burning of coal in the engine is the result of chemical action between the oxygen of the air and the coal. In somewhat the same way, the food (or substance formed out of the food) combines within our bodies with the oxygen we inhale, to release the energy needed by the living machine.

Growth and Repair.—The constant running of the steam engine causes wear in all its parts, and when a wheel or a rod in the engine becomes worn, it must be replaced by a new one. The shoes you walk in and the bicycle you ride wear out after a while and have to be repaired or discarded. Our bodies, likewise, are wearing out day by day, and if there were no provision for repair, they would soon waste away. There is, however, constantly going on in the body, not only a process of waste, but also a process of growth and repair; and it is the food we eat which supplies the material for this rebuilding.

If the body is built up faster than it wears out, it grows, as it does in children and young people. When you were a day or two old, you probably weighed only seven or eight pounds. All of the fifty or one hundred pounds of weight you have gained since then have been built out of the food you have eaten.

To get food is the first problem of life, for human beings, as for the birds and the animals in fields and woods. The farmer spends his life cultivating crops for the use of man or for the feeding of animals to be used, in their turn, as human food. The men digging a ditch, or bending over account books in an office, or laboring in a factory, are working for money to be used, first of all, to buy for themselves and their families the food needed to keep their living machines in running order.

The Body as a Chemical Laboratory.—The study of what the body does with this food which is secured for it—in many cases with much labor—is an absorbing one. To change beefsteak and potatoes, bread and butter, bacon and eggs, ice cream and fruit, into human flesh and blood is no simple task. The solid foods must become liquid before they can be used at all, and even liquid foods, like milk, must be changed into other forms.

You perhaps know something about chemical laboratories where chemists study various substances, and combine and change them so as to make new ones. The human body is a kind of laboratory where food is built up into living matter, and where a great many other chemical changes are always going on—many of them so complicated that no chemist in his laboratory can as yet imitate them.

Oxygen, the Supporter of Life.—Just as the living body requires food, so also it requires oxygen, a substance contained in the air. A furnace needs both coal and a draft of air to burn the coal; and the body, likewise, needs not only food but air to "burn" the food. From the air we breathe, we get the necessary oxygen; and just as the fire goes out when there is no supply of air, so the body could not live if we ceased to breathe. Perhaps you have an aquarium and have learned that if too many fishes are put into it they soon die, because the supply of oxygen in the water is not sufficient.

The Wastes of the Body.—The furnace with which we have been comparing the human body needs another important thing, besides coal and a draft of air. The ashes must be removed or the grate will clog and the fire will be checked. In the body, also, waste matter is formed, which,

like the ashes in the furnace, must be regularly carried away.

Team Work in the Body.—One of the most striking things about our living machine is the way in which all its

Fig. 4.—Like the furnace, the body needs a supply of fuel (food) and oxygen, to furnish its heat or energy and, like the furnace, it requires that its burned-out waste materials shall be regularly removed.

parts work together. When you do anything, even as simple an act as walking across the room, there are dozens of different muscles at work to produce the movements of your legs; and each muscle must act at just the right time and in just the right way to take a step. Perhaps you have watched a

baby learning to walk and have thought what a hard thing walking really is. Yet how easily you yourself can move about,—and if you are walking or running and come to something in the way, how quickly you can stop short or turn aside to pass it! Did you ever think what happens in such a case? Your eyes see the obstacle in your path and send a message to the brain; and another message, quick as a flash, goes out to the muscles, telling some of them to stop and others to begin to act.

The Normal Working of the Living Machine.—When the muscles and the nerves and other parts of the body are all working well, we say that a person is in good health. Such a person feels alert and cheerful and full of energy. But when some part of the body is working badly, there is illness or disease.

Some people are born with bodies that are not very strong; and when such people are ill, we should be very kind and patient with them. A great many cases of illness, however, are due not at all to weak bodies, but to carelessness or ignorance. It is easy to injure a body that is naturally healthy and thus keep it from working well. Many a child has a toothache simply because his teeth have not been cared for, or a headache because he has strained his eyes by working in a poor light. Many a child catches measles or whooping cough merely because he has played with other children who had these diseases.

The Care of the Living Machine.—Many kinds of machinery require such careful and skillful attention that books are written about them, to be studied by those in charge of their operation. This book will help you to learn how the living machine works, and what you should do to keep your body in the good working order that we call *health*.

When we study **physiology,** we learn about the parts of the body and the ways in which they act. The study of **hygiene** deals with the management of the body and those things which we can do—as well as those we should avoid—in order to keep it strong and well. The study of **sanitation** deals with the effect of outside things on the body, and helps us to protect it from disease germs and other injurious things which might come from outside the body to harm it.

Each one of us has a very complicated and delicate machine in charge. The chief purpose of this book is to teach young people how this machine works and how to care for it properly and get the most out of it.

Questions for Discussion and Review

1. What are some of the different kinds of cells in your body?
2. What is protoplasm?
3. What advantage is there in having each organ do its own special work? Can you tell something of primitive Indian life and compare it with a modern city, to make the preceding question clearer?
4. During a street-car strike in a large city, the car service was cut to one half. Describe the effects this strike might have had on the life of the city. Show how a corresponding "strike" in the human body might have far-reaching results.
5. In what respects is the body like a furnace?
6. How does the body display force or energy? Where does this energy come from?
7. Can you think of two ways in which the body is superier to a machine?
8. Give some examples of team work in the body.
9. Define health, physiology, hygiene, sanitation.

CHAPTER II

THE PARTS OF THE LIVING MACHINE

The General Plan of the Body.—Before the principal systems of organs in the body are described, we should know something of its general plan.

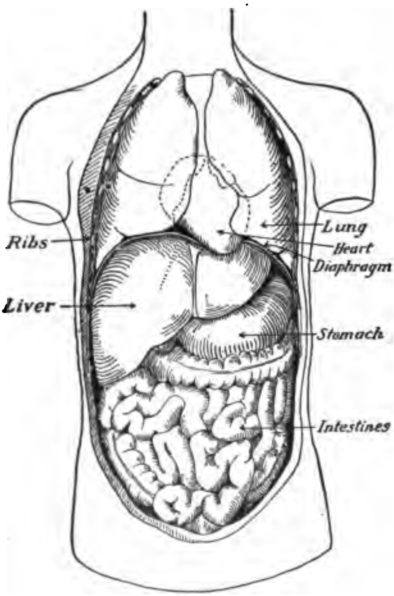

Fig. 5.—The position of some of the principal organs of the body.

The body includes head and trunk, arms and legs. The arms and the legs are practically solid masses of skin, muscle, bone, and other tissue, but the trunk contains two cavities which are not quite filled by the organs in them. The digestive system, a long tube, passes from the mouth down through both these cavities. The upper or **thoracic cavity** (the chest) contains the heart and the lungs, as well as the upper part of the digestive system. The lower or **abdominal cavity** is nearly filled by the stomach, intestines, and other organs connected with the lower part of the

digestive system. The cavities are separated by a dome-shaped muscle, the **diaphragm.**

The Bony System.—The first thing we need in building any kind of machine is a framework, to support and hold together all the different parts. This framework in the human body is made up of the bones. The body is not stiff and rigid, however; it contains many separate bones, which are joined together in such a way that they can move easily at the joints. (See Fig. 6, page 20.)

There is, for example, a row of bones running up the center of the back, which make up the backbone. A series of bones runs down each arm and leg, and branches out into a chain of bones in each finger and toe. A series of hooplike bones, the ribs, protects the organs in the trunk; and a case of bones, the skull, incloses the delicate brain.

The Muscular System.—About half the total weight of the body is made up of the muscles, which are the organs of movement. (See Fig. 7.) They hold the parts of the body in position and give it form and contour.

When you bend your forearm up, the motion is brought about by the shortening or contraction of a stout muscle, attached at one end near the shoulder and at the other end just below the elbow. Muscles move the tongue about and grind the teeth together when we chew our food. Another set of muscles keeps the eye fixed on what we are looking at. Other muscles move the tongue and lips and throat when we speak.

The muscles; however, do more than cause motions that can be seen. There are many movements going on inside the body that we cannot see at all. The heart is a sort of muscle which, by its movements, forces the blood to all parts of the body. The stomach and the other parts of the diges-

tive system contain muscles which move the food along while it is being digested.

The Digestive System.—In the digestive system the food is made liquid and changed into a form in which it can be absorbed. It is first broken up in the mouth by the chewing action of the teeth. Then it passes through the throat and a narrow tube (the esophagus) and goes into the stomach. From the stomach it gradually finds its way into the small intestine, a long coiled tube in which most of the digestion takes place; and finally whatever remains goes to the large intestine. (See Fig. 23, page 52.)

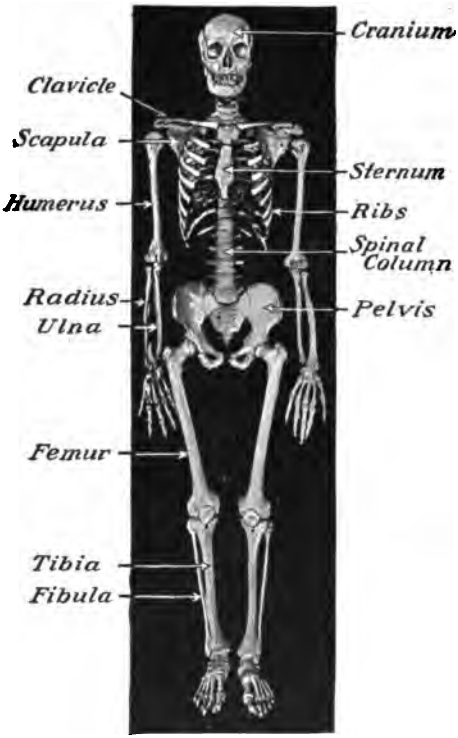

Fig. 6.—The framework of the body.

Digestive juices of various kinds are poured at many points into the mouth, stomach, and intestine, from organs, called glands, in which they have been made. After the food mass has been changed by the action of these juices, the part which the body can use is absorbed through the walls of the small intestine and passes into the blood. The

waste material, which is of no use to the body, passes out through the large intestine.

The Respiratory System.—The oxygen which the body needs is taken in by a pair of organs called the lungs, which occupy a large part of the chest and open into the throat by the windpipe. The lungs are bags or sacs with elastic walls, and every time we breathe, the lungs are enlarged so as to draw in air through the throat.

The lungs are liberally supplied with blood vessels. The walls between the blood vessels and the air passages in the lungs are very thin, and through these walls oxygen from the air passes into the blood. At the same time, carbon dioxide, one of the waste products of the body, passes from the blood into the air spaces and is expelled with the outgoing breath.

The parts of the body that work together in respiration, or breathing, form the respiratory system.

The Circulatory System.—We have seen how the food material passes into the blood after it has been changed in the digestive system, and how the oxygen reaches the blood in the lungs. The blood carries these necessary things to all parts of the body where they are needed.

The blood flows unceasingly through a system of fine tubes, the blood vessels, and the force that drives it is the beat of the heart, which by its regular contractions squeezes the blood into the vessels. Through the walls of the blood vessels, oxygen and food pass into the various tissues of the body. The organs concerned in the work of sending the blood through the body are called the organs of circulation.

The Excretory System.—The blood not only carries food and oxygen, but it also takes away from the tissues the waste matter that is constantly forming and carries

Fig. 7.—The muscular system.

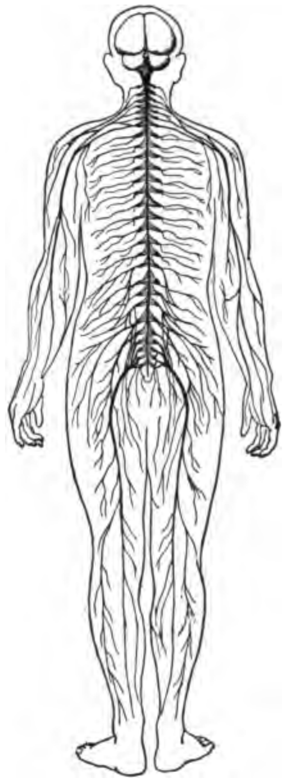

Fig. 8.—The nervous system.

it to the special organs which discharge it from the body. The principal organs which serve to get rid of these waste materials are the lungs, the intestines, the liver, the kidneys, and the skin. Each of these organs takes out certain kinds of waste material. They are called the organs of excretion.

The Skin.—The skin forms a cover for the soft internal parts to keep them from being injured or from drying up, and it is the organ through which we perceive heat and

cold and exercise the sense of touch. It plays an important part in keeping the temperature of the body constant, and assists in excretion by throwing off some of the wastes in the form of perspiration.

The Nervous System.—Perhaps the most important of all the systems of organs is the nervous system, which carries messages from one part of the body to another and keeps all the parts working together.

The nervous system includes first of all the brain, which lies inside the skull, and the spinal cord, which runs down from the base of the brain through the backbone. From both brain and spinal cord, bundles of fine white threads, called nerves, run out to all parts of the body. Some of these nerve threads bring in messages from the sense organs, and some carry messages out to the muscles and glands and other parts of the body, to set them in action. The brain and the spinal cord are the chief managers of the whole complex living machine.

The Sense Organs.—In order that the body may perform successfully the various things it has to do, it must have some means of learning what is going on around it. This is accomplished by means of the sense organs. If you try to walk or to draw or do almost anything with your eyes shut, you will realize how much you depend on the messages which come from outside. The chief sense organs of the body are the eyes and the ears. In the skin are special organs for receiving impressions of pressure, of heat, and of cold. Similar organs in the tongue receive impressions of taste, and others in the nose receive impressions of smell.

Each of the systems of organs which have been briefly considered here will be discussed in detail in succeeding chapters of the book.

Questions for Discussion and Review

1. Name the systems of organs in the body. What is the special work of each?

2. Show by examples how the systems of the body are dependent on one another.

3. Describe some of the movements of the body brought about by the muscles.

4. What are some of the changes produced in the food in the process of digestion?

5. What two different processes go on in the lungs?

6. What are some of the uses of the skin?

7. Of what use are the sense organs?

CHAPTER III

THE BONY SYSTEM

The Function of the Skeleton.—The skeleton or bony system, as we have seen, furnishes a strong framework or support to the body, constructed in such a way that its parts can move and thus help in the motion of the body as a whole. The skeleton also serves to protect certain parts of the body from injury, as in the case of the skull and the ribs.

What the Bones are Made Of.—Bone consists largely of lifeless matter, but it has all been built up out of living tissue. In a very young child, the framework of the body is made of a soft material called **cartilage**. Gradually the cartilage changes to bone, as lime is added to it from the tissues. This makes the bones hard, just as lime gives hardness to clam shells and oyster shells.

All bone consists of hard lime and some softer substances. We can prove this in several ways. If we heat a piece of bone for a long time in the fire, it will become so brittle that at a touch it falls into powder. This is because all the soft connecting material has been burned out, leaving nothing but the lime. A cook extracts much of the softer part of bones when she boils them for several hours, the soft part (called gelatin) being used in making soups. The lime, on the other hand, may be taken out of a bone with acid, leaving the bone so flexible that it can be tied into a knot.

Some of the larger bones, which are hollow, have a soft fatty material called **marrow** in the center.

The Bones in Childhood and Old Age.—All through childhood, the bones are very flexible and contain more living matter than in later life. When a baby first stands on his feet, it is easy to see that the bones in his legs are not stiff and strong. If a child is allowed to walk too early, before the cartilage has hardened into bone, his legs become bent out of shape. There is danger that the bones will keep this bent shape and the child may become permanently bow-legged.

Fig. 9.—The longer bones of the body are in the form of hollow cylinders, which gives them great strength combined with lightness.

The bones of an old person, on the other hand, have less of the soft living matter. They are dry and brittle and break easily. A very slight fall, which would hardly be noticed by a child, will sometimes snap the bones of a person of advanced years.

Parts of the Skeleton.—The human skeleton includes about two hundred separate bones, twenty-eight of which are in the head, fifty-eight in the trunk, and one hundred and twenty in the arms and legs.

The backbone is a kind of column which supports the upper part of the body. Above it is the skull, which in-

closes and protects the brain. The ribs and the breastbone surround the organs in the upper part of the trunk, and a group of hip bones, called the pelvis, help to support the organs in the lower part of the body. The arms and the legs are given strength by a series of long slender bones which run like rods through them. (See Fig. 6, page 20.)

Shapes of the Bones.—The bones are of various shapes, and all are admirably suited for the work they have to do. The ribs are curved so as comfortably to inclose the organs of the upper part of the trunk. The bones of the skull are flattened and curved plates, which form a tight box to hold the brain. In the joints of the wrists and ankles, there are a number of small rounded bones, somewhat like the ball bearings in the wheels of a bicycle. The large bones in the arm and the leg have the shape of hollow cylinders, a form which makes them light yet gives great strength. (See Fig. 9.)

How the Bones are Held Together.—The bones are held together at their joints by tough bands or cords of tissue called **ligaments.** The muscles and tendons (to be described in Chapter IV) also serve to bind together the whole bony system.

Some of the bones are fixed firmly to those that lie next them; this is the case in the skull. Others, like the bones in the arm, are connected by movable joints. At these movable joints, the ligaments hold the bones in place, while allowing them a certain freedom of motion. Between the bones, in many cases, there are layers of cartilage, like the substance of which the whole skeleton is formed at first. In some of the movable joints, there is still another arrangement to make the bones move easily. These joints are covered by little bags filled with a liquid

that keeps the ends of the bones wet, so that they move freely over each other, acting somewhat like the oil that we put into a hinge to keep it from creaking.

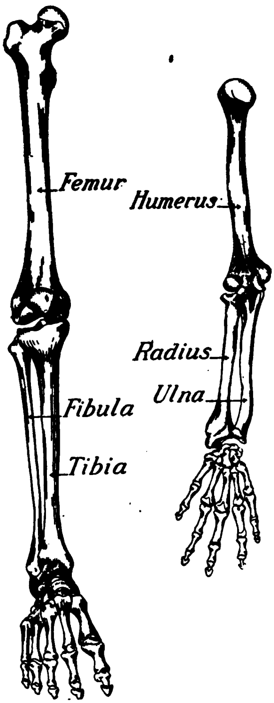

Fig. 10.—The bones and joints of the leg and arm.

Kinds of Joints.—There are several different forms of joints which make possible various kinds of movement. The joint in the elbow is of the simplest kind, in which a bone moves up and down in two opposite directions but not sideways, just as a knife blade does in opening or shutting. The knee joint is of the same kind, and there are a number of others that you can find for yourself. Such joints are called **hinge joints.**

The joint in the shoulder is a different kind, which allows much freer motion in all directions. This is called a **ball-and-socket joint,** because one of the bones has a rounded knob or ball which fits into a cup or socket in the other bone and moves about in it.

Finally, there is a third kind of joint, called a **gliding joint,** in which the bones move or glide over each other in different directions but moving only a little each way. Such joints are found in the wrists and the ankles.

The Spinal Column.—The backbone or spinal column is very strong so that the body may be held firmly, and yet quite flexible so that it may bend easily forward

or backward or from side to side. It is made up of twenty-four distinct and separate ring-shaped bones, called **vertebræ** (vĕr′ tĕ brē) with nine or ten smaller bones at the lower end, which are solidly attached to each other. The vertebræ are piled one above another in a long column slightly curved from front to back. They are bound together by ligaments and by many small muscles. When the muscles on one side of the column contract, the ligaments on the

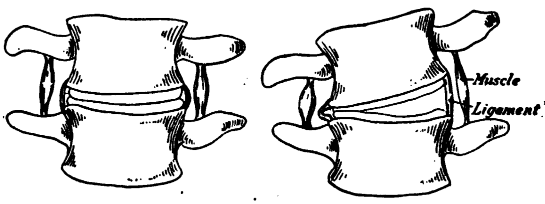

Fig. 11.—Vertebræ with their muscles and ligaments. The right-hand figure shows, in an exaggerated way, how one muscle contracts and the opposite muscle and ligament relax, when the spinal column bends to one side.

other side stretch and the vertebræ tilt slightly on each other.

The vertebral rings have large prongs or teeth, to some of which the ribs are attached. Through the center of the rings runs the spinal cord, which is thus carefully protected from injury,—a very important thing, since the cord is as necessary for the life of the body as the brain itself.

The backbone, when seen from the side, is not straight but is somewhat S-shaped. This form allows a freedom of movement which the body would not have if the backbone were simply a straight column.

The Ribs, Breastbone, and Pelvis.—The principal organs of the upper part of the trunk are inclosed in the bony cage formed by the twelve pairs of hooplike **ribs.** The ribs are

joined to the spinal column at the back, and all but the lowest two pairs are joined at the front to the breastbone or **sternum.** The whole set of ribs can be slightly raised or lowered by a special group of muscles. You can feel this motion of the ribs when you draw a deep breath. The hip bones, which together form the **pelvis,** make a bowl-shaped support for the organs in the lower part of the trunk. (See Fig. 6.) These organs are supported also by powerful muscles in the front wall of the abdominal cavity.

The Skull.—Eight bones, firmly joined together, make a strong, rounded case or box, called the skull or **cranium,** in which rests the brain. The edges of these bones are irregular and fit each other tightly. At the base of the skull, there is a large opening through which the spinal cord enters from the backbone. In the front are openings through which pass various nerves, including those from the eyes. The jaw bones, which hold the teeth, and the bones of the face are attached to the cranium.

The Bones of Arms and Legs.—The number of bones in each arm and each leg is the same (thirty), and the arrangement of twenty-nine of them is the same in each case. There is one bone in the wrist not present in the ankle, and the front of the knee has a protecting bone (the knee-cap) not found in the elbow.

The bones of the arm are attached at the shoulder by the large, broad shoulder blade (**scapula**) and the **clavicle** or collar bone, which is a delicate bone often broken by a fall. You can feel your collar bone extending from the breastbone to the shoulder. In a similar way, the bones of the legs are joined to the lower part of the backbone by the broad and strong pelvis.

In both arm and leg, there is a single bone running

down to the elbow or knee, called the **humerus** in the arm and the **femur** (fē′ mŭr) in the thigh. Below the elbow or knee there is a pair of long parallel bones running to the wrist or ankle, called the **radius** and **ulna** (ŭl′ nȧ) in the arm and the **tibia** (tĭb′ ĭ ȧ) and **fibula** (fĭb′ ū lȧ) in the leg. (See Fig. 10.)

Fig. 12.—The bones of wrist and hand as they appear in a photograph taken with the x-ray. The rays pass through the flesh and leave no shadow, but the bones and the ring on the finger are clearly recorded on the plate.

In the wrist there is a group of eight small bones, and in the ankle there are seven. In the palm of the hand and the instep of the foot there are five parallel bones, which connect with rows of two or three bones in each finger and toe.

The joints of the arms and legs are excellent mechanical devices. The humerus has, at the upper end, a rounded knob which fits into a socket in the shoulder blade and turns easily, while its lower end has sockets in which the two bones of the forearm move. Similarly, the femur is attached at the top to the pelvis, and its lower end is rounded and fits into the bones of the lower leg in such a way as to permit the knee to move easily.

The movements of the wrist and the ankle, in which a number of small bones play a part, are even more compli-

cated than the movements of shoulder and elbow or hip and knee, and the fingers are capable of the most complex movements of all. The toes of young babies move almost as easily as their fingers, but the toes of grown people usually lose this power in greater or less degree.

Holding the Body Well.—As the skeleton is a flexible framework, it may take various positions, which are good or bad in their effect on the body as a whole. Posture depends on the muscles which control the position of different parts of this framework. With the same equipment of bones, one body may be stoop-shouldered and slouching and another may be erect and well-knit. One of the first things to learn in managing the human machine is to hold the body well.

The backbone, as we have seen, is meant to be slightly curved, so as to give elasticity. In people who do not sit or stand straight, these curves become greatly exaggerated, leading to round shoulders and a drooping head.

Bad posture is not only ungraceful but unhealthy. If the back and shoulders are not held properly, the lungs and other internal organs do not get a sufficient supply of blood.

If a good posture is not maintained, the muscles develop unequally, and it becomes more and more difficult to hold oneself well. Among growing children, correct posture is therefore particularly important. Every boy and girl who wishes to have a strong and graceful body should keep the back straight, the shoulders square, and the head high.

The Correct Position for Standing and Sitting.—When standing, the head, body, and legs should be poised one above the other so that a line dropped from the front of the ear falls within the forward half of the foot. The shoulder blades should be flat across the back and the feet

should be directed straight forward (not outward). "This is the position of the long-distance walker, the mountain climber, the best all-round athletes; it is the position of command and authority and is found predominant in the great leaders of commerce and public life. On the other hand, collapsed positions are characteristic of both physical

Fig. 13.—Good posture, slouching posture, and exaggerated posture. Which is which?

Typical poses presented as examples by the American Posture League.

and mental weakness. They constitute a distinct aspect of weakness and illness, from the tuberculosis patient to the feeble-minded.[1]"

In sitting, the body should be bent only at knees and hips, and the head, neck, and trunk should be kept in one straight line.

Stand in front of the mirror some day in your ordinary resting posture and see how you look. Notice whether

[1] Jessie H. Bancroft, in *The Teaching of Hygiene.*

your head is well up or bent forward, whether your shoulders are square or bowed, your chest rounded or flat, your knees sagging or straight, your feet set squarely on the ground and

Fig. 14.—Bad effects of faulty school seats. Note how the boy in the front seat of the second row from the right is strained by a desk and seat that are too high.

side by side, or tilted over on weak ankles and toeing out or in.

Some Causes of Faulty Posture.—One bad deformity of the backbone is called lateral curvature. The backbone seen from front or back should be straight. Sitting at a school desk which is too low, or too near the seat, may lead not only to round shoulders, but to a bending of the backbone to one side or the other. If seats in the schoolroom are adjustable, such harmful effects may be avoided. When there are no adjustable seats, a wooden support screwed

under desk or chair makes it possible to raise one or the other to fit the pupil's needs. If both seat and desk are too high, a board or some bricks may be placed on the floor for a footrest.

Another thing that strains the body out of shape is the frequent carrying of a heavy weight on one arm. School-books and heavy bundles should be divided and carried some on one arm and some on the other.

Tight clothing may do serious damage by cramping the movement of the ribs and getting them out of shape. It may twist the organs out of place and crowd them together,

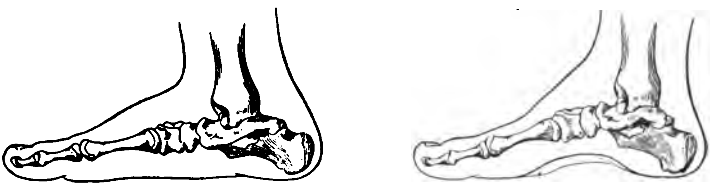

Fig. 15.—Which of these feet is a normal and healthy one?

so that they cannot develop and do their work properly. It may injure the breathing muscles and seriously affect the stomach, the intestines, and the liver.

Hygiene of the Feet.—The weight of four-footed animals is divided almost evenly and produces very little strain on the feet. Man's upright position, which places the whole weight of the body on two feet, causes a much greater strain, especially at ankle and instep.

The healthy normal foot has a well marked arch under the instep, and this arch is very important in giving springiness or elasticity to the step. When the arch is broken down, as in the deformity known as flat-foot, the nerves and blood vessels underneath are injured. Pains far up the back may be caused by the resulting strains. Exercise

of the muscles which move the toes, if begun in time, will often correct this condition.

The twenty-six bones of the foot are held in place by numerous muscles and ligaments. It is impossible to give these muscles proper exercise and to keep the feet in healthy condition, if the shoe is too narrow or too pointed. A hygienic shoe should be everywhere as wide as the sole of the foot, and wide enough in front to permit the toes to move freely. The inner edge of the shoe should be straight, so that a line drawn back from the middle of the great toe touches the heel. The heels should be low and broad. The soles and uppers should be flexible, so that the foot may be bent freely. A high shoe should not be so tightly laced at the top as to interfere with circulation. A porous shoe, like one made of russet leather, is much better than an enamel or patent leather shoe, because it allows the escape of moisture and prevents overheating of the foot.

Fig. 16.—Good and bad shoes and (Fig. 17) the shapes of their soles. Which shape is bad and why?

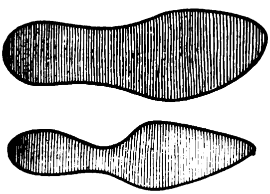

Fig. 17.

Corns are usually due to the wearing of shoes that are too tight or of a wrong shape, or to faulty posture. It is

much wiser to wear shoes of the proper size than to suffer the pain which narrow shoes may cause.

Injuries to the Bony System.—Sometimes when a person twists or strains some part of the body too violently, the ligaments which join the bones are torn loose. This is called a **sprain.** If the twist is so severe as not only to break the ligaments but to pull the joints of the bones out of place, it is called a **dislocation.** When a person has a bad fall or other accident, the bones themselves may be broken. Both ligaments and broken bones will in time knit together and heal, but in order that this may occur it is important that a dislocated or broken bone should be put in its proper position by a physician as promptly as possible after the accident.

Questions for Discussion and Review

1. Of what two substances are the bones composed? What quality does each substance give?

2. Some of the larger bones are not solid; what advantage is gained?

3. Why should a baby be prevented from walking too soon?

4. A boy and his grandfather were in an accident in which they were thrown from a carriage. They were thrown in about the same way, but the man had several bones broken and the boy was merely bruised. How do you account for this? If the boy and his grandfather had each broken an arm, which would probably have recovered sooner?

5. Describe the principal parts of the skeleton.

6. How many different-shaped bones can you locate? Tell how each is especially adapted to its work.

7. How many hinge joints can you locate? How many ball-and-socket joints?

8. Why should you think that the shoulder joint would be more easily dislocated than the knee joint?

9. What would be the disadvantage of having a hinge joint at the wrist?

10. How are the different parts of the spinal column held together?

11. Explain how the spinal column bends.

12. What advantages are there in holding the body well?

13. What are some of the deformities that may come from bad habits in standing and sitting?

14. James has a desk that is too high for him; Mary's is too low. What bad deformity may come to both James and Mary, as a result?

15. Make a study of the heights of seats and desks in your schoolroom, noting whether they are arranged so that the children can sit comfortably without twisting or bending over.

16. Charles has been carrying his books in his left arm, so as to leave his right arm free. Jane told him to divide them, or to change them frequently. Explain why Jane's advice was good.

17. After your bath, step with wet feet on the floor and examine your footprints. Are they curved and irregular or nearly straight in outline? Which should they be?

18. Why is it said that soldiers are only as strong as their feet?

19. Describe a shoe which is ideal from a hygienic standpoint.

20. What danger is there in narrow, pointed shoes?

21. What is a sprain? A dislocation?

CHAPTER IV

THE MUSCULAR SYSTEM

The Muscles.—There are some five hundred separate muscles in the human body and they make up about half its weight. They are of many different shapes, and of sizes ranging from a large muscle in the back that weighs several pounds to the tiny muscles that move the eyelids. Muscle in an animal is the portion we eat as lean meat.

Fig. 18.—The biceps muscle and its tendons.

If a muscle is studied under the microscope, it is found to be composed of a great number of tiny muscle fibers, each an inch or an inch and a half long and $\frac{1}{2500}$ to $\frac{1}{250}$ of an inch thick (somewhat the shape of a long leather shoe string). Each of these fibers can contract; and when all the fibers of a muscle contract together, the whole muscle shortens. It is this contraction, or shortening, of the muscles which causes movement.

How the Muscles Move the Parts of the Body.—The larger muscles are fixed, at one or both ends, to bones or other parts of the body, by means of tough whitish strings called **tendons.** These tendons help to make the machinery of movement simple and efficient. There are, for example,

many different muscles which move the fingers. Some of these are relatively large. Instead of running down into the wrist to make it bulky and awkward, the larger muscles stop in the arm and are attached to tendons which extend down to the bones in the hand. You can see these tendons working in the back of your hand when you open and close it. They do not themselves contract but are pulled by the shortening of the muscles in the arm. At or near the point

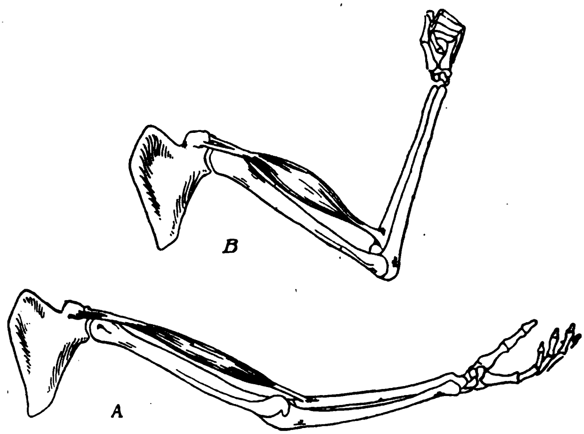

Fig. 19.—How the biceps muscle bends the arm.

where they are attached to the bones, the tendons are often held in place by ligaments.

When a muscle contracts and pulls on its tendons, the bones or other parts of the body to which the tendons are attached must, of course, move toward each other. Figure 19 shows how the **biceps** muscle in the upper arm raises the hand. This muscle is attached at one end to the bones of the shoulder and at the other end to the upper part of the forearm. If you hold your arm in position A of the figure and raise your forearm, the biceps muscle shortens and

thickens. You can feel it do this if, at the same time, you put your other hand on your upper arm.

When you want to straighten the arm again, there is another muscle on the other side (the **triceps**) which, by contracting, pulls on the lower end of the forearm and draws it back into line with the upper arm.

Antagonistic Action of Muscles.—The biceps and triceps are good examples of what is called **antagonistic action.** One muscle pulls the arm up and the other pulls it down; the position of the arm depends on the balance between these two pulls. In this way one of the pair of antagonistic muscles serves as a check upon the other. It prevents the motion from going too far and permits a much more exact control of movement than would otherwise be possible.

Varied Work of the Muscles.—All of the various movements of the body are made by contractions of muscles. Every change in the position of the ribs, the bones of the arms and legs, or the backbone is due to the shortening or lengthening of muscle fibers.

It is not only when we move, however, that the muscles are active. Holding any part of the body still requires the action of a great many muscles, but the antagonistic muscles are then pulling equally hard in opposite directions. If you hold your arm out straight in the air for a few minutes, you will become very tired from the muscular work that you have been doing.

The body, in standing, is held erect by great bands of muscle which run up the back and hold the spinal column straight and the head erect. (See Fig. 7.) A skeleton, such as you may have seen in a museum, would double up and fall over if it were placed upon its feet, for lack of muscles to hold it up. The organs of the trunk are held in place

by flat sheets of muscle in the abdominal wall. When we shiver with cold, it is because a chill has upset the normal relation between the tiny muscles of the skin, and they pull first one way and then another, instead of being evenly balanced.

Muscles of the Digestive and Circulatory Systems.—Besides the muscles which move the skeleton, there are a great many other muscles in the body which we do not ordinarily think about, but which are constantly at work to keep the human machine running.

Did you ever wonder what becomes of your food after you have swallowed it? It does not just fall down. It has to move through the esophagus and the stomach and the intestines (see Fig. 23, p. 52) and in order to do this it must be pushed along by the contraction of muscles in the walls of these organs.

It takes a great deal of force to drive the blood through the blood vessels that extend all over the body. This is done mainly by the heart, which is really a powerful muscle. The daily work of this organ is said to be equivalent to the lifting of a hundred-ton locomotive a foot in the air. The walls of all the blood vessels contain layers of muscles which, by their contraction, regulate the size of the blood vessels so that each part of the body gets the necessary supply of blood.

Voluntary and Involuntary Muscles.—The muscles that move the arms and the legs, the skin of the face, the tongue, and many other parts of the body are under the control of the will; they are called **voluntary** muscles. We can move such muscles when we wish to do so. Most of the organs inside the body, however, like those in the digestive and circulatory systems, work automatically. The muscles

which control these movements are called **involuntary** muscles; we cannot contract them at will.

Keeping the Muscles Strong.—Any one can strengthen his muscles by exercise. When a muscle is used, it grows more powerful. You can tell a baseball pitcher or a blacksmith by the big muscles of his arm, and a man who has rowed on a crew by the powerful muscles of his back.

Fig. 20.—An example of the value of well-trained muscle—Babe Ruth.

It is not necessary or wise for all boys and girls to take part in athletic competitions which require great development of special sets of muscles. Every boy or girl, however, ought to take enough active exercise to develop all the muscles of the body to a reasonable degree. Nowadays we like to see girls as well as boys strong and vigorous, and able to excel in games.

Effects of Muscular Exercise on the Body as a Whole.—Muscular exercise is necessary, not only for the development of the muscles, but also for the health of the body as

a whole. When we exercise the muscles, we exercise all the other organs. The heart and the blood vessels work better. The lungs take in deeper draughts of air. The appetite is increased, and the digestive system does better work. The waste products of the body are carried away more rapidly. The brain is clearer and the spirit more cheerful.

The natural love of play gives most young people plenty of exercise, but as they grow older many of them become so busy or so lazy that they forget to give their muscles enough to do. Really vigorous health requires active muscular exercise.

Exercise to Develop Special Parts of the Body.—If any particular part of the body is weak, special kinds of exercise may be used to develop it. A child who does not use his lungs properly can take special breathing exercises. There are special exercises for developing the muscles of the legs, the arms, the chest, the back, the trunk, and other parts of the body. Certain exercises, such as dancing, are especially valuable, not so much for developing the muscles themselves, as for training the power of balancing or properly coördinating the action of various muscles.

One of the best things about the Greek people in the great days of their country was their admiration for the perfect and graceful human body. In their wonderful statues they showed the ideal body of an athlete, and each Greek boy and girl was expected to reach this ideal, as far as possible, by training and developing the body.

The Best Kinds of General Exercise.—The best exercises (aside from those used to correct special defects) are those which develop as many as possible of the different muscles of the body. Such exercises are brisk walking and

running, rowing, riding, swimming, and playing tennis, baseball, and football.

It is better to exercise in the open air than indoors, but merely being outdoors is not enough. Leisurely walking

Fig. 21.—The Greek ideal of manly strength and beauty.

is not exercise. You must use your muscles vigorously, so as to make the heart beat faster and the chest expand fully, if you are to get the best results.

Exercise in the form of games has a special value because games train and develop the eye and the brain as well as the

muscle. Athletic sports and games that require team play teach young people how to coöperate with others, and to subordinate self to the good of the team.

Every boy and girl should have at least one form of exercise that he or she likes to do and learns to do well. It may be swimming, riding, tennis, basketball, skating, or brisk, hard walking. The important thing is to have the

Fig. 22.—Class drill in the gymnasium is excellent for training the coördination of the muscles.

habit of some kind of outdoor exercise and to love it, so that as you grow older you will turn to that sport for relaxation.

The Gymnasium.—Exercise taken in the form of games cannot, however, take the place of systematic drill in the gymnasium. Such drill, as has been pointed out, develops the special muscles that particularly need developing and trains the balancing or coördinating power of the body. To many people who live in crowded cities, the gymnasium furnishes a valuable opportunity for exercise; and even those

who are fortunate enough to have opportunities for outdoor sports are made and kept fit for these activities by training in the gymnasium.

Few people can play games or even go to the gymnasium every day, however; but the body needs some real exercise *every day* to keep in the best condition. Every boy and girl should form the habit of going through a few simple exercises each morning on rising. A valuable set of exercises of this kind worked out by the famous athlete, Mr. Walter Camp, is described in a later chapter (p. 366).

The Danger of Over-exercise.—All good things can be abused. Exercise draws the blood to the muscles and the skin. It is unwise, therefore, to take active exercise just before or after a heavy meal, for then the blood is needed in the digestive organs. Exercise at any time should not be carried so far as to tire one unduly. Great harm may be done by severe games, like boat races or Marathon runs for boys, or hard basketball games for girls.

Your object should not be to break records or win games, but to have a strong, healthy body and to play school games and the game of life gallantly, whether you win or lose.

The Effect of Alcohol and Other Poisons on Muscular Efficiency.—Aside from the need for exercise to develop the various muscles and the nerves by which they are made to act together, the most important thing to do in order to have a strong and efficient muscular system is to *avoid poisons.* The muscles and the other organs of the body may be chemically injured or poisoned in various ways. Sometimes men who work in trades where they have to use poisonous compounds, like certain lead salts, are poisoned by them. Sometimes people who eat too much, or too much of particular things, are poisoned by the results of decay of food

in their intestines. Among the commonest injuries of this kind are those due to alcoholic drinks and narcotic drugs. It is recognized to-day that the use of such drugs does very great harm, and a special chapter will be devoted to the subject later. It will be well, however, to consider briefly the effect of alcohol upon the health of the various systems of organs, as they are taken up in turn.

The influence of alcohol on the work of the muscles has been studied by physiologists who devote their lives to finding out all they can about the human body. Hellsten of Sweden, for instance, determined the power of certain muscles and their resistance to fatigue by an instrument called the ergograph. In this machine the finger may be put into a strap which is connected with a weight by a thread over a pulley. The finger is bent downward again and again, each time lifting the weight on the other side of the pulley. The amount of the lift is recorded automatically by a point which traces an up-and-down line on a moving surface of smoked paper. Studies made with apparatus similar to this show that even moderate doses of alcohol cause a loss of about eight per cent in the power to do muscular work.

This conclusion from laboratory experiments is borne out by practical experience. Men on forced marches and those who have to do especially heavy work are no longer given alcoholic drinks, for it has been found that the effect is not to increase but to diminish endurance. College athletes in training for athletic victories are, of course, never allowed to use alcohol or tobacco or any other harmful drugs.

Sir Frederick Treves, a famous English physician, has said in this connection: "As a work-producer, alcohol is exceedingly extravagant, and like all other extravagant

measures, leads to a physical bankruptcy. It is also curious that troops cannot work or march on alcohol. I was . . . with the relief column that moved on to Ladysmith, and, of course, it was an extremely trying time by reason of the hot weather. In that enormous column of thirty thousand, the first who dropped out were not the tall men, or the short men, or the big men, or the little men—they were the drinkers, and they dropped out as clearly as if they had been labelled with a big letter on their backs."

Questions for Discussion and Review

1. What is the special work, or function, of the muscular system?

2. How are muscles attached to bones and other parts of the body?

3. Examine the tendons in a chicken drumstick. How are they arranged?

4. How does a muscle work in moving a part of the body?

5. When a muscle contracts, how does it change its form?

6. Raise your arm with palm up. Clench your hand and bring it slowly to your shoulder. What happens in your upper arm? What happens when you extend your arm again?

7. How is the body held in an erect position?

8. What causes shivering?

9. I know a boy who can drink a glass of water while he hangs head downward from a bar. How is this possible?

10. What is the difference between the action of the muscles of the stomach and those in the hand?

11. What effect does active exercise have upon the muscles?

12. A boy broke his right arm and kept it in splints and bandages for several months. When the splints were removed, this arm was soft and weak, and smaller than the left arm. Why?

13. What are some of the effects of exercise on parts of the body other than the muscles?

14. Why is it a good plan to learn some games and sports which you can continue to play when you are older?

15. You gain speed, accuracy, and quick thinking in games. Of what special value are these in everyday life? Give examples.

16. How does team work learned in games help to make boys and girls better citizens?

17. Jane and Rose are both fond of basketball. Jane plays a brilliant but erratic game, always depending on her own play to win. Rose is steady and uses passes to other players who are in a better position to throw for a basket. Which is the more valuable member of the school team?

18. John had been working hard all the morning and was so hungry that he ate an unusually large dinner. Some of the boys came to see him directly afterward, and they all went swimming. John had been in the water only a short time when he was seized with a cramp in his stomach. What caused the cramp?

19. Is beer a good drink for men on an exploring party? Give reasons for your opinion.

CHAPTER V

THE DIGESTIVE SYSTEM

Why We Need Food.—You know that if you go past your regular mealtime without eating, you feel hungry. You know also that if a person does not eat for a long time he grows weak, and that if he continues to go without food he finally starves. Three times during the day, or oftener, we put food into the mouth, chew it more or less carefully, and swallow it. Do you know what becomes of it afterwards?

Food is needed, as we have seen, to furnish the body with the energy necessary for its activities, and to make good the constant waste of living tissue that goes on during life. The human body gets its energy from the energy already stored up in other matter: in the bodies of other animals (in the form of meat, fish, and eggs), or in plants (such as grains, vegetables, and fruits). But the energy for the life of all animals really comes from the energy in plants, because plants furnish food for animals which, in turn, furnish food for other animals. The plants obtain their energy from the sunlight, by means of a wonderful power in the living matter of green leaves. So eventually we all get the energy for our life processes from the sun, by way of the green plants and the animals.

The Process of Digestion.—It is easy to put food into the mouth, but there is a great deal more to be done before the tissues of the body get the benefit of it. Animals cannot use all kinds of food, as a furnace can burn all kinds of coal.

The food must first be changed into a liquid, and the chemical substances in it must be changed into other substances that the body can use. The food on which any kind of animal can live depends on the power of the animal to change it in this way. A beefsteak is the muscular tissue of an ox, but an ox cannot eat steak and make new muscle of it; he makes his muscle out of grass.

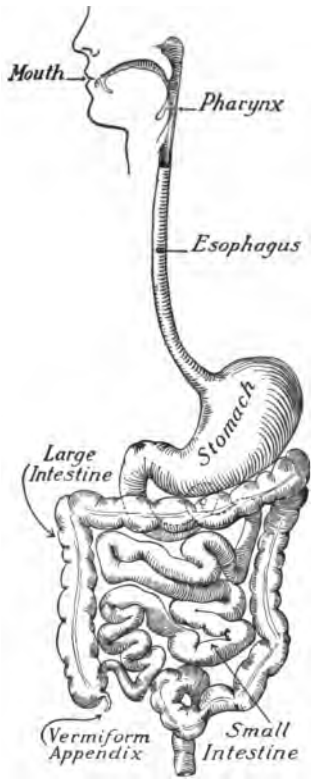

Fig. 23.—The principal parts of the digestive system.

This work of changing the food into the forms the body needs is called **digestion**; and when the organs fail to do their work properly, either because they are diseased or because we place too heavy a burden upon them, we say that we have indigestion.

The work of preparing the food so that it may pass into the tissues is done in the digestive tube or **alimentary canal.** In this tube the food is broken up and chemically changed or *digested* by the action of the digestive juices, and the part which the body needs is *absorbed* through the wall of the tube into the blood. The parts of the food which cannot be used are not absorbed but are discharged as waste material.

The Organs of Digestion.—The alimentary canal is really

a single tube running through the body, larger in some parts and smaller in others. It is lined with soft tissue, such as we can see in the throat. This tissue is pink because it is so full of blood vessels, and is kept moist with a sticky mucus (mū′ kŭs), for which reason it is called **mucous membrane.**

There are six principal parts of the digestive tube, each of which has its own special work to do. They are the **mouth,** the **pharynx,** the **esophagus,** the **stomach,** the **small intestine,** and the **large intestine.** Their general form and position in the body are shown in Fig. 23.

The Digestive Juices.—The digestive juices of the body contain curious substances, called **enzymes** (ĕn′ zīms), which have the power to digest or change foods in ways that no chemist can imitate.

The body makes these juices in special chemical factories of its own, called **glands.** The saliva, or digestive juice of the mouth, for instance, is made in small glands which connect, like little branching caves, with the floor of the mouth. If you have ever had mumps, you know where two of the salivary (săl′ ĭ vȧ rĭ) glands are, because it is in them that the inflammation and swelling of this disease take place. Besides the salivary glands in the mouth, there are tiny glands in the walls of the stomach and the intestines, and two large glands, called the **pancreas** (păn′ krē̇ ăs) and the **liver,** which open into the small intestine. All of these glands manufacture, or secrete, digestive juices, which are called secretions of the gland.

As soon as we taste or smell food that we like, a nerve message tells the salivary glands to get ready to help in the work of digestion, and they begin to discharge their juices. We say at such times that "the mouth waters."

Internal Secretions.—In connection with the glands which take part in digestion, something should be said in regard to glands which perform other functions in the body. The digestive glands, for the most part, discharge their secretions into the alimentary canal. Other glands have no opening through which secretions are poured out; their enzymes pass from the tissues directly into the blood, to be carried to various parts of the body where they are needed. Such secretions are called internal secretions. Among the glands of this kind are the **thyroid glands** (thȳ′ roid), which lie in the neck on each side of the windpipe. The secretion of these glands is necessary for health, and when they do not produce it normally, definite diseases follow.

The Mouth and Its Work.—The mouth is the vestibule of the digestive system. The tongue forms its floor, and the cheeks its sides. The roof of the mouth is called the **palate.** From the back of the palate hangs a soft finger-like piece called the **uvula** (ū′ vū̆ lȧ), and at each side of the throat at the back are the rounded **tonsils.**

Two things happen to the food in the mouth. It is broken up into a fine pulp by the action of the teeth, and some parts of it are changed chemically by the saliva. The processes of chewing and mixing are helped along, and the food is finally passed on toward the pharynx (throat) and esophagus, by the action of the active and muscular tongue.

The teeth and the way in which they should be kept healthy are discussed in the next chapter, but we may consider here the importance of the teeth in digestion. The rest of the digestive machinery of the body is meant to work on a semi-liquid pulp, not on lumps of solid food.

One can force down masses of unchewed food by swallowing hard and washing them down with liquid; but this is a very bad habit which puts a strain on the stomach and the rest of the digestive system, and is likely to cause illness. A dog bolts much of his food without chewing it, but a dog's digestive system is different from ours, and he can do this without harm. Our flat grinding teeth were given us to use; and if we use them properly, our food will not only be ground up into a fine paste, easy to digest, but will be well mixed with the necessary digestive juices of the mouth.

Another reason for slow eating is that only in this way do we really taste our food. The taste, besides being pleasant, is a helpful aid in the selection of a proper diet. When people chew their food and eat slowly, they tend to eat more wholesome foods. Moreover, the pleasant taste of food encourages appetite and stimulates the flow of digestive juices.

The Work of Digestive Juices in the Mouth.—The digestive juices which are mixed with the food in the mouth not only moisten the food and make it easier to swallow, but also play an important part in digesting starchy foods. Potato and bread, for instance, are largely composed of starch; and starch does not dissolve in water and cannot pass through the walls of the digestive tube. An enzyme in the saliva acts on this starch so as to change it to sugar, and the sugar then dissolves very easily. If we chew thoroughly a piece of bread or some other starchy food, it finally begins to have a slightly sweet taste because of this change of starch to sugar.

The Pharynx and the Esophagus.—After the food is swallowed, it passes down through the pharynx and the esophagus into the stomach. The walls of the esophagus contain

muscles which contract and push the food along, much as you squeeze library paste out of a tube with your fingers.

Digestion in the Stomach.—The stomach, as shown in Fig. 23, is a large pouch or bag, holding about three pints in a grown person. Within its strong muscular walls, the food is moved round and round and churned up into a thin paste, before it is squeezed on into the intestines. At the same time, it is mixed with digestive juices from glands of the stomach. These juices contain a weak acid and a powerful digestive substance called **pepsin.** The last of the food stays in the stomach about four hours, and when it passes into the small intestine it is a rather thick fluid.

The digestive juices of the saliva, as we have seen, act on the starchy foods, but the **gastric juice,** which is mixed with the food in the stomach, serves to digest another class of foods, the proteins (such as white of egg or meat).

It is easy to show how the gastric juice acts by a simple experiment in the classroom. Pepsin, the enzyme which digests meat in the stomach, can be bought at the drug store (this pepsin has been prepared by extracting it from the stomach of a calf). In order to do its work, it must have an acid present, such as is poured into the stomach by the glands. Pieces of meat should be placed in four test tubes. These tubes should then be half filled with (1st tube) pure water, (2d) a weak solution (2 per cent) of hydrochloric acid, (3d) a solution of pepsin, and (4th) a solution of the weak acid plus pepsin. After the tubes have been put away for half an hour in a warm place, the meat in the first three tubes will remain unchanged, but in the fourth it will begin to dissolve and will become soft and slimy from the combined action of the pepsin and acid.

If the gastric juice is not poured out in sufficient amount

or is not strong enough, if the stomach muscles do not do their work and churn the food well, or if the food is improperly cooked or is swallowed without chewing, painful and sometimes dangerous indigestion may result.

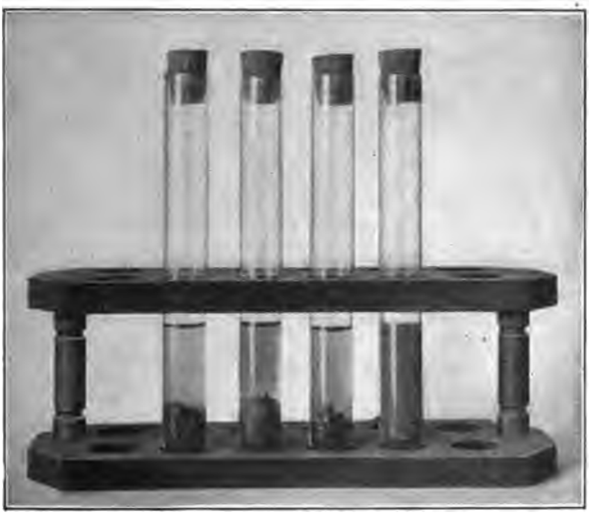

Fig. 24.—Action of the digestive juices of the stomach.

A piece of meat and some water have been placed in each tube. To the first tube (from left to right) nothing has been added; to the second, hydrochloric acid alone; to the third, pepsin alone; to the fourth, both pepsin and hydrochloric acid. In the last case only, the meat has been dissolved so as to color the whole of the liquid.

Digestion in the Small Intestine.—From the stomach the food passes to the small intestine. We often speak of the stomach as if it were the chief organ of digestion, but this is not the case. The digestive juices of the small intestine are even more important than the gastric juice in getting the food ready to be absorbed into the tissues.

The small intestine is called "small" because it is a nar-

row part of the digestive tube, but it is really very long, usually measuring from twenty to twenty-four feet in a grown person. It is coiled up and down and back and forth and fills a large portion of the lower part of the trunk.

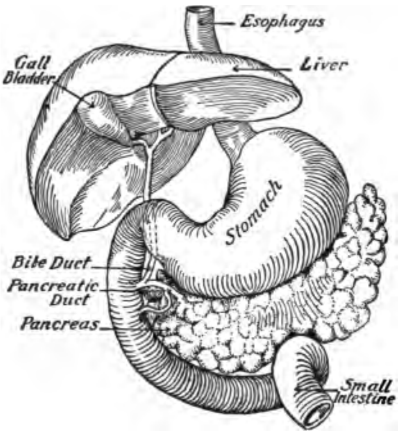

Fig. 25.—The stomach and the larger glands connected with it.

While the food is being passed through the small intestine by the muscular action of its walls, three more digestive juices are mixed with it. These are the **pancreatic juice,** the **bile,** and the **intestinal juice.** The pancreatic juice and bile are discharged by large glands called the pancreas [1] and the liver, respectively. The intestinal juice is discharged by small glands in the wall of the intestine itself. The pancreatic juice is by far the most important of these, and, indeed, of all the digestive juices. About a quart of it is poured into the intestine each day, and it acts on all kinds of foods—starchy and sugary foods, meat foods, and fats.

The Process of Absorption.—Most of the actual absorption of digested foods into the blood occurs in the small intestine. The food takes a long time to pass the length of the intestine—from ten to twenty hours. The absorption is not at all a simple soaking-up process like that by which a sponge takes up water. There is a living wall or membrane

[1] The pancreas of a calf is the portion that is eaten as sweetbread.

between the digested liquids in the intestine and the blood into which these liquids must be transferred; and there are many things about this transfer that even the wisest scientific people do not understand.

The great length of the intestine helps to make absorption possible. In order, however, to give an even greater

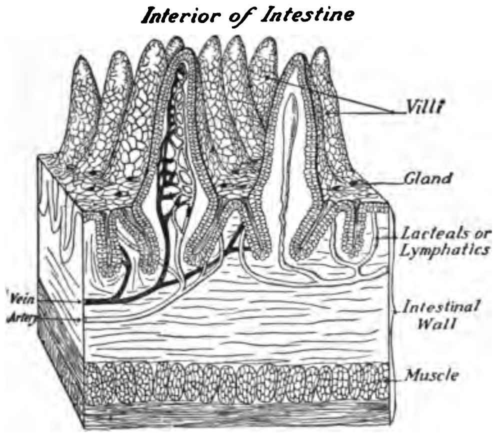

Fig. 26.—A section through the intestinal wall, showing the villi.

surface for this work, the surface of the intestinal wall is increased by being raised up in the form of millions of little finger-like projections called **villi,** which are so small that they can just be seen with the naked eye. These villi are richly supplied with blood vessels, and in some way the living wall of the villi selects from the digested food the things the body needs and passes them into the blood, leaving in the intestinal tube the material that cannot be used.

Storage of Food in the Body.—When the food reaches the tissues, some of it is used at once to make good the waste which is always going on, and some of it is stored for the

future. Thus, in the liver cells there is deposited a starchy substance called **glycogen** (glī′ kŏ jĕn); fat is stored in a great many parts of the body, particularly under the skin. Animals that sleep all through the cold winter go into their hiding places in the fall loaded with fat, and come out very

Fig. 27.—Claude Bernard (1813–1878), the French physiologist, who discovered glycogen in the liver.

thin in the springtime, having lived all winter on their stored-up or reserve food.

The discovery of glycogen in the liver was one of the most important single steps in the growth of our knowledge of the human body. Claude Bernard, a great French physiologist (1813–1878), was studying the changes which food undergoes after it is absorbed into the body, when he found

to his surprise that the blood in the vein leading from the liver contained sugar, even though no sugar-producing food was being fed to the animal. This led him to the discovery that the liver changes the sugar that comes to it in the blood (when sugar-producing foods are eaten) into glycogen, and stores it, to be changed again to sugar and given up to the blood when needed.

Good Habits of Eating.—The digestive organs should have their regular habits, like all the other parts of the body. At the usual meal hours the stomach and the intestines do their work better than at other times, and people often harm their power of digestion seriously by taking meals too early or too late or by eating between meals.

Breakfast should be a sufficient meal but not a heavy one. Fruit, cereal, eggs, and bread and butter make an excellent breakfast. There should be one hearty meal, in the middle or at the end of the day, and the other meal should be a fairly simple one.

One should not at any meal eat so heavily as to overload the stomach; nor should one eat too much indigestible food, such as pickles, olives, pie, and cake. Candy is a common cause of illness among children, not because of any harm in the candy itself, but because too much of it is eaten at a time. Too much water at meals, particularly if it is very cold, is bad for the stomach. Violent exercise or mental excitement just before or after meals also interferes with digestion; and quiet and calmness at mealtimes are important factors in digestive hygiene.

It may seem a nuisance to think about these things. It is, of course, easier and pleasanter at the moment to eat what you like. There is no momentary pleasure, however, that is so great as the pleasure of having a healthy body,

being able to play as you want to, and feeling well all the time. A grown person who has chronic indigestion is generally disagreeable and unhappy, and it is worth while to form good eating habits so as not to grow up to be such a person.

The Large Intestine and Its Work.—The position of the large intestine is shown in Fig. 23. From the point where the small intestine joins it, it passes first upward on the right side of the body nearly to the level of the stomach, then across to the left side and downward to its opening.

When the food mass reaches the large intestine, it has been robbed of nearly everything that can be used by the body. All that remains to be done is to absorb the water out of it and press it into a solid mass to be discharged. The large intestine serves as a storage reservoir for the waste material until the time comes for getting rid of it.

Just beyond the point where the small intestine joins the large intestine, a small slender sac branches off from the large intestine. This sac, on account of its wormlike shape, is called the **vermiform appendix.** Sometimes the action of germs growing in the appendix causes the disease known as appendicitis. In such cases, it may be necessary for a surgeon to open the abdominal cavity and remove the appendix.

The Importance of Keeping the Intestines Clear.—**Microbes** are little living plants and animals, so tiny that they cannot be seen except with a very powerful microscope. When milk sours or meat spoils, the change has been caused by microbes. In the lower part of the intestinal tube, enormous numbers of microbes are at work all the time, breaking up the food and waste materials and forming from them new chemical compounds.

Some of these microbes in the intestines produce substances that are poisonous to the body, and it is therefore important that food wastes should not remain there long. If food stays in the intestines too long, the poisons formed by its decomposition are absorbed by the blood and carried to all parts of the body. This is why constipation, or lack of proper movement of the bowels, is very harmful. Many people have headaches and feel dull and miserable just on account of such poisons from the intestines.

It is important to form the habit of clearing out the intestines *regularly* at least once a day, and perhaps oftener, so as to keep the intestinal tube clean. If this does not happen naturally, the remedy should be found, not in taking medicines, but in drinking plenty of water and eating more fruit, green vegetables, and coarse foods, or in more exercise, sleep, and fresh air.

When the bowels move too frequently, the condition is known as diarrhea. Diarrhea is often due to the growth of special kinds of harmful microbes in the digestive tract. The best remedy is to cut down the food, particularly meats and eggs, and to take a dose of castor oil or some other medicine which will help the body to get rid of the microbes and poisons. If the trouble continues, a doctor should be consulted.

Questions for Discussion and Review

1. Show how the energy of the food which you ate for dinner yesterday had its source in the sun.

2. How must the food we eat be changed before it can be absorbed, and how is this change accomplished?

3. What kind of lining is found all through the digestive canal?

4. Name the parts of the alimentary canal in the order in which the food comes to them.

5. Find out all you can about enzymes.

6. What are glands? What do the digestive glands have to do with the process of digestion?

7. What are internal secretions?

8. What structures can you see in your mouth when you look in the glass?

9. What part of digestion takes place in the mouth?

10. Are the teeth organs of digestion?

11. What advantage is there in eating slowly?

12. Would you expect to find the digestive apparatus of a dog, a horse, and a man alike?

13. What difference does it make in digestion if your food tastes good and is properly seasoned?

14. Mrs. Julian was eating lunch in the school lunchroom with her five-year-old son. He was not so hungry as she wished, so she fed him, giving him a mouthful before he had time to chew the preceding mouthful. His mouth was filled all the time, even when she was forcing him to drink a glass of milk. Will she make him fatter and stronger by this process?

15. What happens to the food in the stomach?

16. What type of food is digested by the saliva? By the gastric juice?

17. Which organ of digestion, the stomach or the small intestine, has the more important work to do?

18. What classes of foods are digested in the small intestine?

19. Why is the food delayed so long in the small intestine?

20. How is the lining of the small intestine constructed to provide special means for absorption?

21. Where does the digested food go after it is absorbed by the villi?

22. If more food is digested and absorbed than is needed for the building of the tissues, what becomes of it?

23. Where is the fat in the body stored?

24. What is glycogen and where is it found?

25. Who was Claude Bernard?

26. Why is it better for the digestion, if we eat at regular hours and avoid eating between meals?

27. What is the work of the large intestine? Why is it important to get rid of the waste products of digestion?

CHAPTER VI

HYGIENE OF THE TEETH

Temporary and Permanent Teeth.—Our first teeth begin to grow out from the gums when we are only a few months old. There are twenty teeth in this first or temporary set, and the last of them generally appear by the end of the second year. These first teeth begin to loosen and fall out when a child is about six years old, but some of them re-

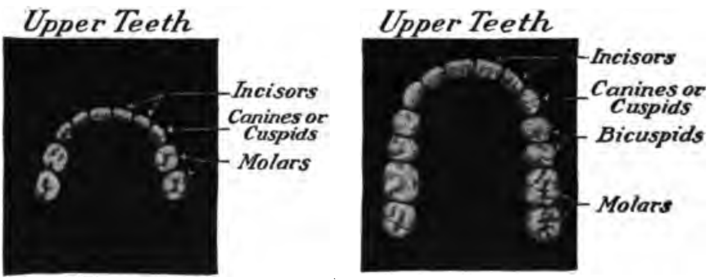

Fig. 28.—The arrangement of the temporary teeth (left) and of the permanent teeth (right) before the appearance of the "wisdom teeth" or third molars.

main until he is twelve or older. As the first or temporary teeth go, the second or permanent set come in to take their places. There are thirty-two of these permanent teeth. The last of them, the four "wisdom teeth," may not appear until sometime between the ages of seventeen and twenty-five years or even later.

The Different Kinds of Teeth.—The arrangement of the permanent teeth is shown in Fig. 28. Flesh-eating animals, such as the dog, have only tearing or biting teeth, and some

of the grass-eating animals, such as the cow or horse, have only flat grinding teeth. We have both kinds—four sharp cutting teeth or **incisors** in the front of each jaw; six **molars** or flat grinding teeth at the back of each jaw; and two **cuspids** and four **bicuspids** (partly for cutting and partly for grinding) at the sides of each jaw.

The Structure of a Tooth.—The part of a tooth which we can see above the gum is called the **crown.** Underneath the gum is a **root,** by which the tooth is held in place (see Fig. 29). The greater part of the tooth is made of a hard bony substance called **dentine.** On the crown, this is covered with a still harder layer of smooth shining **enamel,** and on the root with **cement.** Inside the dentine is a soft mass of pulp containing nerves and blood vessels.

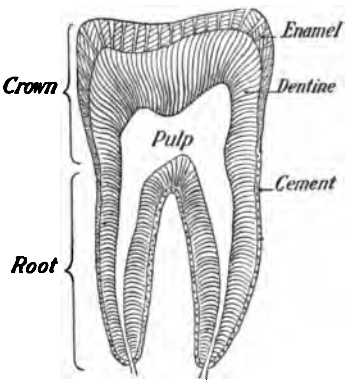

Fig. 29.—The structure of a tooth.

Tooth Decay and Its Causes.—When particles of food are left between the teeth, they decay and the chemicals produced by microbes act on the enamel and gradually destroy it. When the enamel has been injured, the dentine underneath is rapidly attacked and at last, if the cavity is neglected, the decay reaches the nerves. Such decay of the teeth is known as **dental caries** (kā′ rĭ ēz).

There is another very common and serious disease, called **pyorrhea** (pī ŏ rē′ *ȧ*), in which the microbes infect the edges of the gums. Teeth affected in this way may become loosened and finally fall out.

Effects of Tooth Decay.—Neglect of the teeth produces many bad effects. The odor from an unclean mouth is most unpleasant to other people. The teeth in such a mouth decay, and as they begin to grow sensitive, chewing is neglected, and the stomach is likely to be loaded with unchewed food. Contact with sweet or hard substances, or extreme heat or cold, may then result in aching teeth, and lead to painful visits to the dentist, to have the tooth filled—if it is not too late.

The evil effects of tooth decay are not limited to the teeth themselves. Recent studies have shown that the microbes which cause decay of the teeth may form poisons which affect the whole body. In some cases the microbes themselves, after growing in the tissues about the teeth, may get into the circulation and pass to other parts of the body, where they set up serious diseases, such as rheumatism and heart disease. A neglected tooth is a gateway through which some of our worst germ enemies may gain entrance.

Care of the Teeth.—The enamel is the natural protection of the teeth, and it is very important that it should not be injured. It is fairly brittle and may easily be chipped, so that one should be careful not to crack hard nuts with the teeth or to pick the teeth with hard objects which might splinter them.

On the other hand, thorough chewing of the food, and particularly of fairly hard foods like crusty bread, tends to polish the surfaces of the teeth and to prevent deposits on them. The coarse food which savage people eat helps to keep their teeth in good condition, and the more of such food we eat, the better it is for us. But as most of us do not

eat enough hard foods, especial care is necessary to prevent decay and to keep the mouth healthy.

The most important aid in keeping the teeth in good condition is, of course, the toothbrush. It has been said that in an army—where the greatest care must be taken of the health of the soldier—his toothbrush ought to be in-

Fig. 30.—The toothbrush drill. Mobilizing against the microbic enemies of the teeth.

spected as systematically as his gun. The teeth should be brushed regularly night and morning, at least. It is well to brush them after each meal, because the sooner deposits of food are removed, the better. Once a day a good tooth powder or a good tooth paste should be used to aid in cleaning the teeth. It does not matter whether paste or powder is used. Either will help to remove the sticky materials that collect on the teeth, and are hard to get off with the brush alone.

At other times, the brush and plain water alone are sufficient.

The toothbrush should not be too large, and the bristles should be of medium hardness and so shaped that they will get between the teeth. Both sides and the top of the teeth should be thoroughly brushed. It is much better to brush down or up from the gums to the cutting edge instead of sideways across the teeth, because when the brush passes sideways the bristles do not get in between the teeth. The most effective method is to place the bristles of the brush firmly against the teeth, apply pressure as if trying to force the bristles between the teeth, and then give the brush a rotary or scrubbing motion. Care should be taken to go over both the back and front of the cutting teeth in both jaws, as well as the flat crowns of the grinding teeth. The gums above and below the teeth and the surface of the tongue should also be cleaned.

When the brushing is finished, lukewarm water should be taken into the mouth and forced between and around the teeth several times, by means of the lips, cheeks, and tongue. This is as important as the proper use of the toothbrush itself. The tooth toilet should take from three to five minutes.

Even the best use of the toothbrush will not always keep the spaces between the teeth entirely clean. If food particles collect in these spaces, a bit of dental floss may be passed up and down between the teeth, care being taken not to injure the delicate gums.

Dental Care of the Teeth.—In spite of all that we can do, a hard substance called **tartar** often deposits upon the teeth, and decay sometimes begins before we know it. Inspection of the teeth of school children usually shows that

at least two out of three mouths seriously need dental attention.

It frequently happens that the teeth are crowded irregularly into the mouth instead of being evenly arranged. Such teeth are unpleasant in appearance and are likely to decay, because there are many cavities between them to catch bits of food. Since the teeth in distorted jaws do not meet properly, adequate chewing is impossible. The dentist can straighten teeth of this kind and improve the appearance and health of the child at the same time—if the matter is attended to early enough.

It is well to have the teeth examined by a good dentist at least twice a year. He will remove the tartar, polish the teeth, and care for any beginnings of decay. There will be only slight pain and little expense. If the teeth are not examined in this way, decay is likely to start somewhere; and when a toothache finally drives us to the dentist's chair, there is suffering in store, and it may be toc late to save the tooth. It is as true here as elsewhere that Prevention is better than Cure.

Questions for Discussion and Review

1. How many sets of teeth do we have? When do they appear? How do they differ?
2. What are the advantages in having teeth of various shapes?
3. Describe the structure of a tooth.
4. What causes teeth to decay?
5. What effect do decayed teeth have on the digestion?
6. Describe your ideal of what a set of teeth should be. Notice the people you meet and see how many have teeth which are ideal.

7. What danger is there in cracking nuts or biting thread with your teeth? In picking your teeth with a pin?

8. It is said that the peasants of Scandinavia, who eat much hard black bread, have fine teeth. Explain.

9. Name several means of keeping the mouth and the teeth clean.

10. What kind of toothbrush is best?

11. Describe the correct use of the toothbrush.

12. How often should the toothbrush be used?

13. A little girl in the slums of a big city said that her father had a toothbrush, but that she didn't like to use it. Was she right or wrong? Explain.

14. Most large public school systems require an examination of the teeth of all school children. They also provide dental clinics where the necessary work on teeth is done at a nominal price. Why is this considered necessary?

15. Why should crooked teeth be straightened?

16. How often should teeth be examined by the dentist?

CHAPTER VII

HYGIENE OF FOODS

Fig. 31.—A wheat field in the Middle West, one of the places where the energy of the sunlight is changed into food for us.

Where Our Foods Come From.—We eat a great many different kinds of foods, which come to our tables from all over the world, and hundreds of different animals and plants contribute to our daily meals. It would be fascinating to trace the story of even a single breakfast. The orange perhaps grew in a grove on the sunny shores of Florida. The rice may have been cultivated in Texas. The cream you pour on it probably came from the milk of cows in your own state, and the sugar, from a tall plant in the cane fields of Louisiana. The bread was made

from wheat grown in the grain fields of the West; the butter may have been churned from the milk of a cow in Wisconsin; and the eggs were laid perhaps by hens in Kansas.

In other parts of the world men eat things that seem very strange to us, and some people thrive on what appears to be a very limited menu. The Chinaman eats rats and soup made of a sticky bird's nest. The French epicure enjoys dishes prepared from frogs and snails. The East Indian makes rice the greater part of his diet, while the Eskimo eats great quantities of fat and whale oil. Yet they turn all these curious things into good human muscle and nerve and other tissue.

The Principal Kinds of Foods.—Different as these various foods are in appearance, texture, and flavor, they are in reality made up of only a few kinds of substances, which are so important that every one should know about them. They are water, proteins, carbohydrates, fats, and salts.

Almost all foods contain a certain amount of **water,** though they may seem quite dry and hard. It is not surprising to know that milk is 85 per cent or more water, and an orange 65 per cent water; but it hardly seems possible that in a piece of beefsteak 60 to 70 per cent is water, and in a slice of bread 35 per cent, and that the body itself is about 70 per cent water. Water is constantly being given off from the lungs, the skin, and the kidneys. In order to make good this loss, we ought to drink about three pints, or six glasses, of water a day, besides the water we get in our foods.

Proteins are the food substances which are most abundant in meats and animal foods. Peas, beans, and certain other plant foods also contain a good deal of protein.

The white of egg (egg albumin) is a good example of such a food, being made up almost entirely of protein and water; and lean beef contains little but these two substances.

Fig. 32.—What milk is made of. The bottles show the actual amounts of the various substances in a quart of milk; they are (from left to right) water, sugar, fat, protein, and ash.

Carbohydrates (kär′ bō̇ hī′ drāts), on the other hand, occur most abundantly in plant foods, such as potatoes and cereals. Boiled potatoes are 20 per cent carbohydrate, and good bread over 50 per cent. Starch and sugar are the two commonest kinds of carbohydrate in our foods.

Fats are found in largest amounts in animal foods. We can often see the fat in various cuts of meat. Eggs contain about 10 per cent of fat, and milk about 4 per cent.

Our foods also contain **salts** or minerals of many kinds, not only the kind of salt that comes to the table in the salt shaker, but other mineral substances like it. These salts are present only in very small amounts, but the body needs a dozen or more different kinds in order to keep healthy. Lime, for instance, is essential to the building up of the skeleton, and iron and other salts are necessary for other tissues of the body.

People who live on a restricted diet of only a few kinds of foods, particularly cooked foods, may not thrive, even though they have plenty of all the five food elements described above. This has led to the theory that there are peculiar substances, called **vitamins** (vī tȧ-meens), in certain foods, which are necessary to the body. In order to supply these elements, the diet should always contain a moderate amount of uncooked foods, such as raw fruits, lettuce, and tomatoes. Fruits and vegetables are important articles of diet for another reason: because the alkaline products formed from them in digestion neutralize the acid products formed in the digestion of meats, which are harmful to the body when present in excess.

Classification of Common Foods.—The Life Extension Institute Manual on *How to Live* (by Professor Irving Fisher and Dr. E. L. Fisk) gives the following table of some common foods classified in regard to their richness in protein and fat. The foods in the lower left-hand corner of the table, which are poor in both protein and fat, are the richest in carbohydrate.

Common Foods Classified

	Poor in Fat	Rich in Fat	Very Rich in Fat
Very high in Protein	White of eggs Codfish Lean beef Chicken Veal		
High in Protein	Shellfish Skim milk Lentils Peas Beans	Most fish Most meats Most fowl Whole egg Cheese	
Moderate or Deficient in Protein	Most vegetables Bread Potatoes Fruits Sugar	Peanuts Milk Cream soups Most pies Doughnuts	Fat meats Yolk of eggs Most nuts Cream Butter

The Values of Food Substances.—As we have already learned, we need foods for at least two general purposes: to build up new body tissue to replace that which is constantly wasting away, and to supply the energy for the various activities of life. The protein foods, especially, supply the first need—the building up and repair of body tissue. Proteins may also furnish energy, but the chief energy-producing foods are the carbohydrates and fats.

A general idea of the energy value of various kinds of food may be obtained by driving off the water they contain (as by drying for a long time in the sun) and then burning them. Heat is a form of energy, and whatever burns has energy, or the power of producing heat. Butter and sugar burn in a hot fire even without previous drying. Bread and

meat burn freely after the water has been dried out. On the other hand, vegetables, such as cauliflower or spinach, and fruits dry almost to nothing and burn very feebly. If salt is put on the top of the stove, it does not burn at all, for salt contains no energy, although salts are necessary

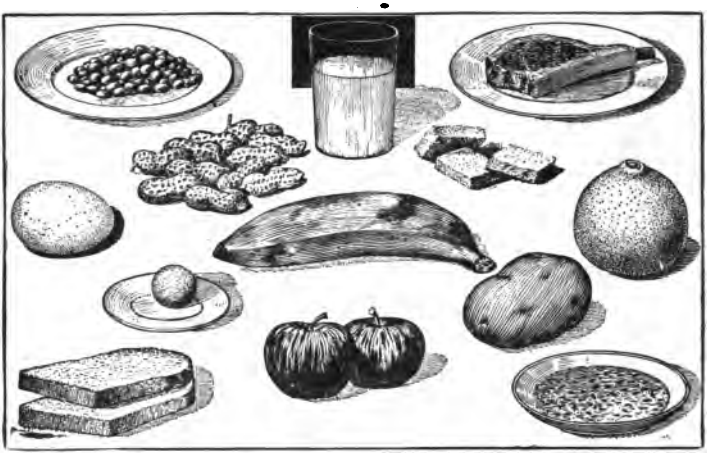

Fig. 33.—Portions of different foods each yielding approximately 100 calories of heat energy. They include: an ordinary serving of beans, 3 large lumps of sugar, 1 large banana, 11 double peanuts, 1 large egg, 1 potato, 1 chop, 2 slices of bread, 1 orange, 2 apples, $\frac{2}{3}$ of a glass of milk, 1 pat of butter, and an average serving of oatmeal.

for the upbuilding and the healthy working of the body.

The energy value of food is measured in units called **calories**, just as flour is measured in pounds. One calorie of heat energy would warm one kilogram (about two pints) of water one degree Centigrade. One large egg, two medium slices of white bread, an ordinary portion of butter, or one large banana, each contains about 100 calories of food energy. To keep the body in good condition, the average

grown person needs 2500 calories a day—or somewhat more, if he has much muscular work to do.

There is a great difference in the amount of energy that can be obtained from different kinds of food at the same cost. For instance, 100 calories in the form of an egg cost ten times as much as 100 calories in the form of flour. It is important that people who buy food, and those who pay for it, should know something about the energy value of different foods, in order that they may get the greatest value for the money spent. The relative amount of energy value to be obtained for ten cents in buying some common foods is shown in Fig. 34 and in the Appendix on page 391. Actual prices are much higher today, but the relative values of different foods remain much as indicated.

How These Facts were Discovered.—One way of finding out the food needs of the body is to study the diet that people select and thrive on, when they can choose the foods they want. A more exact way is to keep people or animals in a carefully built, tight room, called a calorimeter chamber. The heat given off from their bodies to the air and the walls is measured; the air, which goes in and out through special pipes, is measured and analyzed; the food eaten is measured and analyzed; and so are all the excretions or discharges from the body. In this way it is possible to measure exactly the calories of energy which the body takes in as food and the calories which it gives off in heat and in work done. This sort of study of the food needs of the body was begun in Munich by a pioneer German physiologist, von Pettenkofer, and is carried on in many laboratories all over the world to-day.

Importance of Variety in Foods.—It must be remembered that the energy value of food is not the only thing to be

FOOD MATERIALS	Price per pound — Cents	Ten cents will buy — Lb.
Beef, round	14	.71
Beef, sirloin	20	.50
Beef, shoulder	12	.83
Mutton, leg	16	.63
Pork, loin	12	.83
Pork, salt, fat	12	.83
Ham, smoked	18	.56
Codfish, fresh, dressed	10	1.00
Codfish, salted	7	1.43
Oysters, 35 cents quart	18	.56
Milk, 6 cents quart	3	3.33
Butter	25	.40
Cheese	16	.63
Eggs, 24 cents dozen	16	.63
Wheat bread	5	2.00
Wheat flour	3	3.33
Corn meal	2½	4.00
Oat meal	4	2.50
Beans, white, dried	5	2.00
Rice	8	1.25
Potatoes, 60 cents bushel	1	10.00
Sugar	6	1.67

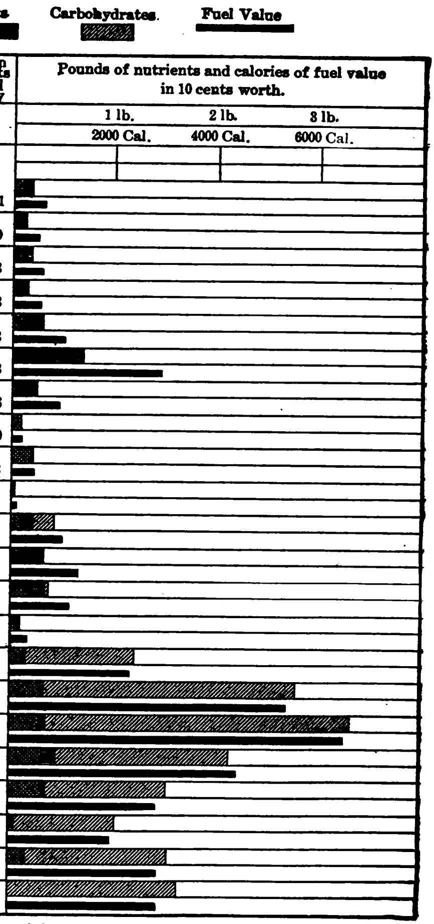

Fig. 34.—Food value and composition of some common foods. U. S. Dept. of Agriculture, 1916. (Actual prices now much higher. See note on page 81.)

considered. As far as energy alone is concerned, we might obtain our 2500 calories a day by eating about twenty ounces of the white of egg or twenty ounces of sugar or ten

ounces of butter. If this were all that were necessary, we could live entirely on such a simple cheap food as bread. Our instincts teach us, however, to eat foods of different kinds, and there is good reason for this.

Certain native peoples in the Philippine Islands and in Japan live largely on rice, which gives plenty of energy but lacks certain important food substances. These people suffer from a peculiar disease called beri beri, which is quickly cured by changing their diet. The sickness called pellagra, which occurs in our Southern states, seems to be closely connected with a diet poor in protein. In olden times, sailors on long voyages used to have a disease called scurvy, which we now know was due simply to the fact that they were fed on salted and cured meats, with no fresh fruits or vegetables. They were starved for one kind of food, though they had enough, and too much, of other kinds. Fruit juices supply the substances needed and quickly clear up any symptoms of scurvy that follow such a one-sided diet. Experience teaches that in order to keep healthy we must have a considerable *variety* of foods which contain all the kinds of food substance the body needs, in the right proportions.

Explanation of Fig. 34. The broad band opposite each food material indicates by its length the amount of nutrients (protein, fats, carbohydrates) which can be bought for ten cents. The three vertical lines at the top show the points on this scale which correspond to 1 lb., 2 lb., and 3 lb., respectively.

The narrow, solid black band indicates in the same way the calories of fuel value obtained for ten cents. The three vertical lines at the top correspond to 2000, 4000, and 6000 calories, respectively, when considered in relation to the solid black band.

For example, ten cents worth of fat salt pork furnishes about 3/4 lb. of nutrients (mostly fat) and about 3000 calories of fuel value. Ten cents worth of fresh dressed codfish furnishes only about 1/8 lb. of nutrients and about 250 calories. Codfish is almost entirely protein.

A Balanced Diet.—Those who are responsible for the feeding of large numbers of people, as in armies, or schools and colleges, and other institutions—make a scientific study of food values and work out regular diets which combine foods in the right amounts and proportions. Such a diet is known as a balanced diet, because in it the various food substances are so combined that they balance one another properly.

A good example of a balanced diet reduced to small proportions for easy transportation is the standard daily field ration of a soldier in the United States army. It contains 12 ounces of bacon, 18 ounces of bread, 2.4 ounces of beans, 20 ounces of potatoes, 1.28 ounces of prunes or preserves, 1.12 ounces of coffee, 3.2 ounces of sugar, 5 ounces of evaporated milk, .16 gills of vinegar, .64 ounces of salt, .04 ounces of black pepper, .64 ounces of lard, and .5 ounces of butter. Protein is supplied by the bacon, beans, and milk, and in small part by the bread; carbohydrate by the bread, potatoes, sugar, milk, and beans; fat by the bacon, milk, lard, and butter. The prunes and preserves help to supply salts and "balance" the ration.

In planning our own meals, it is important to secure a properly balanced diet. The bulk of the diet should be made up of milk and grain products, such as bread and cereals. Vegetables and fruits should be eaten freely. Meat, fish, and eggs should form a part of the diet but should be used in moderate amounts. On page 397 you will find a plan for a well-balanced diet.

Excesses of Diet.—It is probably more common for people to be made ill by too much of certain kinds of food than by too little. You have perhaps had some experience of your own which has taught you how ill one may be made

by eating too much candy or green apples or some other unripe, indigestible fruit.

Many grown people become more or less ill because of overeating, though they may not have a pain, like the boy who eats green apples. They overload their digestive systems and do not know what the matter is when they feel heavy and dull and cross. In such a case, the whole body may be poisoned by the decay of the excess of food in the intestines and by the absorption of poisons formed by the bacteria which are decomposing it.

An excess of protein food is particularly unhealthful, and many people suffer from eating too much meat. Protein should make up about 15 per cent of the calories in the diet.

Meat should generally be eaten only once a day. If the diet is to be an economical and a properly balanced one, it is desirable that an ordinary family should *spend* at least as much for milk as for meat, fish, and eggs; and at least as much for vegetables and fruit as for meat, fish and eggs. Talk this rule over with your family at home.

Fads in Diet.—A great many people get in the habit of thinking they can eat only certain things, and that other foods "disagree" with them. Sometimes this is true, but often the fear of certain foods is only prejudice. Sometimes people have an idea that they should live on nuts or fruits or breakfast foods or some other special food. The ordinary healthy person thrives best with foods of different kinds.

If you wish to cultivate habits of eating which will keep you healthy, you should learn to *eat slowly* and to like all wholesome kinds of vegetables and fruits, bread, butter, cereals, and the like.

When to Limit the Diet.—In hot weather the digestive system does not do its work so readily as at other times, and the body does not need so much energy as when it has to produce a great deal of heat. It is always a good plan, therefore, to eat lightly in warm weather.

In illness, too, it is generally well to limit the diet. After a long illness, the body may need a good deal of especially strengthening food. At the beginning of an illness, however, particularly when there is fever or disturbance of the digestion, the food should often be cut down. Loose movements of the bowels, in particular, mean that little or no food should be taken for a time. Skipping a meal is often better than medicine in such a case.

Pure Food.—The city, state, and national governments are doing many things to prevent fraud in foods of all kinds and to make sure that only pure food is sold. The national Pure Food Law, which was passed in 1906, requires that foods and drugs shall not be adulterated and forbids any false statements on the labels. It is very important that this law should be enforced, so that people may know just what they are buying and may not be cheated into paying high prices for foods that are mixed with cheaper or less desirable substances.

Clean Food.—It is even more important that food should be clean than that it should be pure. Most of the common adulterants of food lower its quality or its food value but do not make it poisonous. If, however, food has been handled by a person with dirty hands, or if flies have crawled over it, it may have become infected with disease germs so as to be poisonous to people who eat it. Not long ago ninety-three people who had attended a church supper in California were taken ill with typhoid fever, because one

of the women who cooked the supper was infected with this disease. Every person should make it a rule never to handle food, or to eat, without thoroughly washing the hands; and all food should be carefully covered and protected from flies and dust.

The Decay of Foods.—Another danger to be considered

Fig. 35.—The Laboratory of the United States Bureau of Chemistry, where goods and drugs are analyzed to see that they conform to the Pure Food Law.

in connection with foods is spoiling or decay. The spoiling of food is always due to germs growing in it. In milk, for example, there are always a few germs; they grow very fast if the milk is in a warm place, and soon spoil or sour it. Sometimes in this spoiling, poisons are formed which make people very ill. All perishable food should be kept cool, so as to check the growth of germs; and one should be very careful not to eat

food, particularly fish or meat, that does not smell sweet.

Cooked and Uncooked Foods.—Some foods, such as fruits, are eaten raw, and we always need some raw foods in our diet. Most of our foods, however, are cooked, and for good reasons.

In the first place, many foods would be hard to digest without cooking. Starchy foods, like oatmeal or bread or potatoes, are highly indigestible unless the little grains of starch have been broken up by thorough cooking. In the second place, the high temperature used in most processes of cookery kills disease germs, and so makes safe many foods that would otherwise be dangerous. Cooking also makes food pleasant to the taste and thus aids in its digestion.

Methods of Cooking.—Cooking is an art of great importance, and girls in particular should take every opportunity of learning how foods may be prepared so as to be healthful and appetizing.

There are four principal methods of cooking: boiling, baking, broiling, and frying. In boiling, the food is cooked in water. In baking or roasting, it is cooked in hot air—in an oven or over a hot fire, but not in the flame. In broiling, the food is cooked directly over the fire itself; and in frying, it is cooked in a pan of hot fat.

Boiling is a cheap and easy method of cooking. It must be remembered, however, that in boiling much of the "goodness" of the food will escape into the water. This is, of course, desirable in the case of soups, but it is a wasteful method when we do not eat the liquid in which the food is boiled. If it is desired that the food substances should be extracted, as in making soup from meat, the food should be put on the stove to boil in cold water.

Otherwise, it should be placed at once in boiling water, which has the effect of searing over the surface and keeping

Fig. 36.—Good cooking makes food more digestible, more healthful, and more palatable.

in much of the strength. One of the advantages of roasting and broiling over a hot fire is that the extreme heat forms a crust which keeps in the juices.

Frying is one of the least desirable methods of cooking,

because fried foods are likely to be soaked with fat, which makes them hard to digest. To obtain the best results in frying, a large quantity of very hot fat should be used. This forms a crust over the food which keeps much of the fat out of it.

A very important aid to the housewife is the **fireless cooker,** which consists of a metal pail inclosed in a box, with an air space between the pail and the inner surface of the box. This air space is partially filled with paper or similar material. Food is heated thoroughly before it is put into the cooker. Often a hot stone is placed in the bottom of the pail before the food is put in. The covers of the pail and the box are closed tightly to prevent, as far as possible, the escape of heat. The food is then allowed to cook very slowly under the influence of the heat already contained in it and that contributed by the stone. This device saves time and expense for fuel, and keeps much of the food value and flavor that are lost in other methods of cooking.

Diet Accessories and Stimulants.—Besides the various foods that are necessary for the body, people take many things with their meals, or between their meals, which are not needed at all as fuel or building materials, but which are eaten or drunk because of their pleasant taste or because of some stimulating effect on the body. Some of these, like soda water and lemonade, are harmless and pleasant when taken in moderation. Drinking soda water or other beverages too often between meals, however, may lessen the appetite for wholesome food and finally do harm.

Tea and coffee are food accessories that are in very general use. Both of them contain tannic acid—a substance which, when used in excess, may be injurious to the mucous membrane of the stomach—and caffeine and other stim-

ulants which act upon the heart and nervous system. There is a great difference in the effect of these drinks upon different individuals, and some people cannot take them at all. They should never be used by children. The word *stimulant* comes from the Latin name for an ox whip; and whipping up the body to do things is always dangerous.

Questions for Discussion and Review

1. What different parts of the world supplied your dinner yesterday?

2. Compare the diet of a Mexican and an Eskimo. Why are they so widely different?

3. Name the principal substances of which our food is composed.

4. Name three foods in which each of these food substances is found.

5. What percentage of the human body is water?

6. Why is it well for us to eat a certain amount of uncooked fruit and vegetables?

7. What is the chief value of protein?

8. What are the greatest energy-producing foods?

9. What do we mean by a calorie?

10. What is the right calorie-value of food for the average man per day?

11. Why does a boy of ten need more food than his mother, who is perhaps twice as large?

12. Why does a man who shovels coal need more food than a man who takes tickets?

13. Criticize the following menus:

I. Macaroni with tomatoes and cheese	II. Cream of celery soup
Baked potatoes	Roast pork, fried potatoes
White bread and butter	Peanut butter and banana salad
Grapefruit salad, with crackers	Doughnuts
Rice pudding	Hot chocolate

III. Clear beef soup
Codfish
Chicken
Peas
Beans
Hard boiled egg salad, with cheese
Baked meringue (white of egg)

14. Make a list of the different foods you ate at one particular meal, and after each food write its chief nutritive value. Can you suggest any improvements in this menu, as regards health?

15. Why is it well to eat a variety of foods?

16. John was pale, undersized, and weak. The doctor said that he was undernourished. Suggest several possible causes.

17. What is meant by a balanced diet?

18. What becomes of the excess, if we eat more food than we can digest?

19. Make a set of rules about healthful eating.

20. Under what conditions should we use less food than ordinarily?

21. What does the United States Government do for the protection of foods?

22. Why is a refrigerator or spring-house a necessary part of every household?

23. What are some of the advantages gained by cooking foods?

24. Give an example of each of the four principal methods of cooking.

25. Which are more easily digested—baked or fried potatoes?

26. Why should doughnuts or crullers be fried in very hot, deep fat?

27. Should we drink water with our meals? Give your reason for your opinion.

28. What effect does the drinking of tea and coffee have upon the human body? Compare the effects of these beverages on grown people and on children.

29. What is the best beverage for boys and girls?

CHAPTER VIII

ALCOHOL AND HABIT-FORMING DRUGS

The Effect of Drugs upon the Body.—Any ordinary food taken into the body has a chemical effect upon the blood and other tissues. It may influence the activity of the body itself, causing the action of some organ to start or stop in response to the effect of the food. We have seen that even the odor of food may cause the flow of saliva.

Such effects of food are merely a part of the ordinary healthy working of the body. There are other chemical substances, not found in ordinary foods, which have special and more powerful effects on certain organs. Such substances are called **drugs.** There are, for instance, certain drugs which can be given to people who do not sleep well, to quiet their nerves. There are drugs which can be used to give people an appetite when they are not normally hungry. There are drugs which can be used to stimulate a heart that is weak and not doing its work well. All such medicines are likely to be exceedingly dangerous, and they should never be used except under the direction of a physician.

In particular, the various kinds of **patent medicines** of secret composition should be avoided. Some of them are drugs that are useful when prescribed by a physician; but many of them contain powerful poisons, and it is foolish to put into the body, which is properly understood by no one but a physician, a drug of unknown nature that may do deadly damage to some of the delicate tissues.

Habit-forming Drugs.—One of the special dangers about certain of these drugs is that they are **habit-forming.** This means that the person who uses them grows, step by step, to depend on them and constantly wants more and more. The body is gradually poisoned by the drug; yet the unhappy victim craves it and sometimes cannot give up the habit, and with health and character broken finally dies as a result. The harm done by such substances as opium, morphine, and cocaine is so serious that their sale is now strictly controlled by law. People are not allowed to get these drugs except on a physician's prescription, and careful records of all their sales must be kept by the druggists. Unfortunately, however, the law does not cover certain patent medicines which contain small proportions of habit-forming drugs.

Alcohol.—There is one drug which has been very generally used in the past, chiefly because it is only within recent years that its harmfulness has been fully appreciated. This is **alcohol,** the active substance of whiskey, beer, wine, and other similar drinks.

It has, of course, always been known that people who use alcohol immoderately are physically and mentally and morally injured, and it has also been known that with many people the craving for more and more alcohol grows, somewhat as it does with the users of habit-forming drugs. The fact that has been realized only recently is the harm that may result from its use even in comparatively moderate doses.

How Alcoholic Drinks are Made.—The weaker alcoholic drinks, such as beer, are made by letting a microscopic plant, the yeast microbe, act on sugary substances. If you add a little of the yeast cake used for bread making to a solution of sugar and water, and keep it in a warm place,

the microbes in the yeast cake will change the sugar to carbon dioxide, which you can see rising as bubbles, and to alcohol, which will be in the liquid though you cannot see it. Such a process is called **fermentation.** In bread making, we use the yeast to make bubbles of carbon dioxide, which lighten the bread, the alcohol formed being driven off by heat when the bread is baked. In brewing beer and other liquors, the yeast is used primarily to make alcohol; ales and certain wines are prepared in a similar way.

Fig. 37.—The yeast plant as it appears under the microscope.

The stronger alcoholic liquors—such as whiskey, brandy, rum, gin, and some of the wines—are made from weaker fermented liquors by **distillation.** The alcohol, which boils at a lower temperature than water, is driven off by heat into pipes, where it is cooled and collected again.

Alcohol as a Food.—There has been a great deal of discussion as to whether alcohol is a food or a poison. Anything that combines with oxygen so as to yield energy in the body may be technically called a food, and in this sense alcohol is a food. On the other hand, it contains no nitrogen and so cannot serve as a tissue builder, as proteins do; and its energy value is unimportant in amount. Even the weaker alcoholic drinks, such as beer, which contain other food substances, would be exceedingly costly sources of food energy, nearly twice as expensive as sirloin steak.

Even if alcohol were a good food and a cheap food, any value of this kind which it might have would be far more than balanced by its special poisonous effects, and it is by these effects that alcohol must be judged.

The Effect of Alcohol on the Digestive System.—Alcohol produces serious effects upon many organs of the body, particularly the brain and the nerves. These effects will be described in later chapters, but something should be said here of the harm done to the digestion and to the general health of the body as a whole.

Strong alcoholic drinks, like whiskey, contain so much poison that even in the throat they smart and sting. The delicate walls of the stomach may be irritated by such strong drinks so that chronic indigestion results.

More important than these external effects of alcohol are the internal ones. The liver suffers particularly, its tissues gradually becoming hard and dead under the action of the poison.

The use of alcoholic drinks before or with meals increases the appetite unnaturally and thus leads to overeating, which, in combination with the alcohol itself, puts a double strain upon the body and contributes in a high degree to many serious diseases.

General Effects of Alcohol on Health.—Every one knows that large doses of whiskey or beer poison the man who is so foolish as to take them. He loses control, first of his judgment, then of his muscles, and finally of his senses. What many people do not understand is that small amounts of these liquors taken over a long period of time may produce just as serious, though less obvious, results. Many of the organs of the body are slowly poisoned by such use of liquor, though no one but the doctor realizes the damage that is being done.

Dr. C. R. Stockard, an investigator in New York, has allowed animals to inhale the fumes of alcohol and has studied the effect upon their offspring. He finds that for several generations the descendants from such poisoned animals are defective and diseased—a fact of the greatest importance in estimating the influence of alcohol as a race poison, and one which could have been discovered only by painstaking experiments of this kind.

Insurance Companies and Their Studies of the Death Rate.—It is very important for life insurance companies to know how people's habits affect their health and chances of living a long time. The person who is insured pays a certain premium to the company each year while he lives, and when he dies the company pays the family the amount of insurance. The rates of premiums to be paid every year are fixed by the general experience of the past, which shows how long people will live on the average. Now if a particular group of people are likely to be short-lived, the insurance companies cannot afford to insure them without charging a higher premium than usual.

In order to find out whether the use of alcoholic drinks shortens people's lives and makes them bad subjects for insurance, many companies, both in the United States and in Europe, have studied very carefully the length of life of people who use alcohol as compared with those who do not; and the results of these studies are most significant.

English and Scottish Statistics.—The statistics collected by the United Kingdom Temperance and General Provident Institution of London showed that the death rate among those who used alcoholic liquors was 38 per cent higher than among abstainers. The Sceptre Life Association of London found the death rate among non-abstainers 52 per cent

higher than among abstainers, and the Scottish Temperance Life Assurance Company of Glasgow found it 43 per cent higher.

American Statistics.—An even more important study was made in the United States in the days before national prohibition by forty-three life insurance companies, who studied their statistics from many points of view. The most important conclusions reached were that the death rate of those who use alcohol steadily and freely is 86 per cent above the normal, while the rate among steady

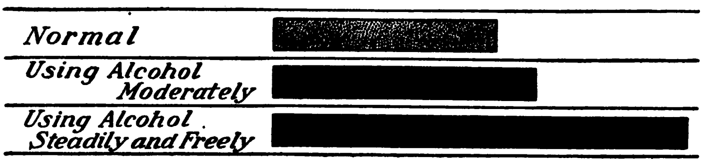

Fig. 38.—Alcohol and the death rate. The lengths of the bars show the relative death rates among users of alcohol compared with the normal rate. From American life insurance statistics.

moderate drinkers (persons taking the equivalent of two glasses of beer or one glass of whiskey a day) is 18 per cent above the normal. (Note the relative length of the three bands in Fig. 38 above.)

Mr. Arthur Hunter of the New York Life Insurance Company says of these figures: "The relatively low mortality among abstainers is not due solely, in my judgment, to abstinence from alcohol. Other factors, such as abstinence from tobacco, are involved. It requires self-control to be an abstainer, and the strength of mind which has made abstinence a habit may affect other habits, such as eating, in which there should be both moderation and discrimination. The low mortality among abstainers may be said to be due to temperance in all things and total abstinence from alcohol."

Summarizing his recent studies of the whole field of American insurance statistics, Mr. Hunter says: "The opinions of the medical directors show that the life insurance companies look with disfavor on applications from persons who drink freely, although not to the point of intoxication, and on those who have taken alcoholic beverages to excess in the past but are temperate now. The statistics prove conclusively that this attitude of mind is based on facts, and that a higher mortality must be expected in these types of users of alcoholic beverages. On the other hand, it is conclusively proved that total abstainers are longer-lived than non-abstainers, even excluding from the latter those who drank immoderately at the date of application for insurance or prior to that time. The experience of the seven American life insurance companies has proved that abstainers have from 10 per cent to 30 per cent lower mortality than non-abstainers; and there is no good reason for believing that if the other companies compiled their statistics, there would be any different result, provided the companies exercised the same care in accepting abstainers and non-abstainers. The American statistics, now published, corroborate the British data in indicating the unfavorable effect of alcohol on longevity, and in showing that total abstinence decidedly increases longevity."

Alcohol as a Public Health Problem.—In view of these facts, it is clear that any one who is interested in making human life longer and happier must be seriously concerned about the problem of alcohol. Many of the progressive Boards of Health have long been making efforts to educate the public as to the dangers of alcoholic drinks, warning people against alcohol as they do against the germ of tuberculosis or any other enemy of the race. A bulletin of the

Department of Health of New York City says, "The discontinuance of the use of alcohol will mark a greater advance in public health protection than anything since the application of our knowledge of the bacterial origin of disease." The New York State Department of Health on one of its educational charts has the sentence, "Alcohol causes more misery, sickness, inefficiency, and death than any other single cause,"—a strong statement, but one which we must heed when it comes from an official and scientific body whose sole interest is the preservation of the public health.

Dr. Henry Smith Williams' summary of the harm done by alcohol, in his book on *Alcohol, How It Affects the Individual, the Community, and the Race*, has often been quoted and may well be quoted once more. "I am bound to believe, on the evidence," he says, "that if you take alcohol habitually in any quantity whatever, it is to some extent a menace to you. I am bound to believe, in the light of what science has revealed:

"(1) that you are threatening the physical structure of your stomach, your liver, your kidneys, your heart, your blood vessels, your nerves, your brain;

"(2) that you are unquestionably lessening your power to work in any field, be it physical, intellectual, or artistic;

"(3) that you are in some measure lowering the grade of your mind, dulling your higher sense, and taking the edge off your morals;

"(4) that you are distinctly lessening your chances of maintaining your health and of living to old age."

Questions for Discussion and Review

1. Explain the difference between foods and drugs.
2. What drug has caused much trouble in China?

3. What is meant by a habit-forming drug?

4. Why are patent medicines dangerous?

5. In history and in stories, we read of the vast amount of drinking which was formerly considered a proof of manhood. Why do we to-day consider alcoholic liquor a dangerous thing, and teach people to avoid it?

6. Compare the part played by yeast in brewing and in baking.

7. Is alcohol a food or a poison? Explain.

8. What organ of the digestive apparatus is especially affected by alcohol?

9. What difference does it make to insurance companies whether a man drinks or not?

10. What conclusions have been drawn from a study of the death rates of abstainers and non-abstainers?

11. If the last four statements of the chapter are true, is the pleasure that may be had from drinking worth the price?

12. Statistics show that more crimes are due to alcohol than to any other cause. Explain.

CHAPTER IX

THE RESPIRATORY SYSTEM

Our Need of Oxygen.—We hardly ever think of the atmosphere about us, except when the wind sets it in motion. Yet the air is a very real substance, as you can feel when you press on a paper bag which has been blown up full of it. This "atmospheric ocean forty-five miles in depth, surrounding our planet, and whirling with it as it whirls around the sun," is made up of two gases, nitrogen and oxygen—about one-fifth oxygen and four-fifths nitrogen, with small traces of other gases.

All living things need oxygen to make life possible, and animals and human beings get their necessary oxygen from the air by the process of breathing. This is why respiration is a sign of life. If a person is seriously injured and unconscious, our first impulse is to see whether he is still breathing.

Oxygen and the body tissues act upon each other so that each is changed in certain ways; we say that the oxygen *reacts* with the body tissues. This process is called **oxidation.** Oxidation in the body has been compared, in Chapter I, to the process that goes on in the fire box of a furnace when the oxygen in the draft of air reacts with the fuel to produce heat energy. In somewhat the same way, although by a longer and more complicated process, breathing furnishes oxygen to react with the body material and to produce life energy.

The Objects of Respiration.—Sometimes when the fire in a furnace or a stove burns badly, you can smell some of the

gases formed by the reaction between the fuel and the oxygen. When the fire burns well, however, the chief thing given off is the gas carbon dioxide, which has no smell. The

Fig. 39.—When a diver goes down to work under water, he must be provided with air to breathe; it is supplied through a special form of helmet.

same gas is formed by the oxidations within the body, and in order to keep the human machine at work, the lungs must obtain a new supply of oxygen and get rid of the carbon dioxide formed in the tissues. This double process is the object of respiration.

The effect of the exchange of gases in the lungs is indicated

by the fact that while the air inhaled is 21 per cent oxygen and only .03 per cent carbon dioxide, the air exhaled is only 16 per cent oxygen and 4 per cent carbon dioxide. It is easy to show the presence of carbon dioxide in the breath by breathing through a glass tube into limewater; a peculiar

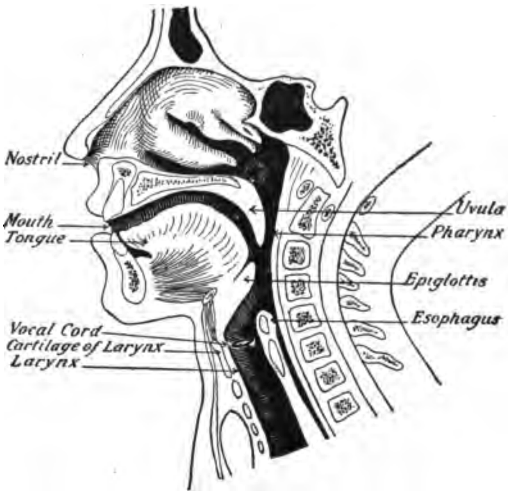

Fig. 40.—The upper part of the respiratory tract.

milkiness will appear as a result of a reaction between the lime and the carbon dioxide.

The Air Passages and the Lungs.—When you breathe properly, through the nose, the air goes through the nasal passages into the back of the throat, for the nose at the back opens into the throat. From the throat the air passes, by way of the larynx, into a tube called the **trachea** or windpipe (see Figs. 40 and 41), which opens out of the front of the throat just below the mouth. The opening from the throat to the windpipe is closed by a little door, the **epiglottis.**

If a particle of food gets by this door and into the windpipe, violent coughing follows, in the effort to dislodge it.

The trachea branches at its lower end into two smaller tubes, the **bronchi,** each of which in turn opens into one of the **lungs.** The lungs are large sacs or pouches which lie one on each side of the chest. As the bronchi enter the lungs, they branch and subdivide again and again, and each branch finally ends in a tiny sac. There are about 725,000,000 of these little sacs in the lungs, and if their surfaces could all be spread out side by side they would cover 2150 square feet. When we take a deep breath, each of these sacs fills with air and swells up like a toy balloon.

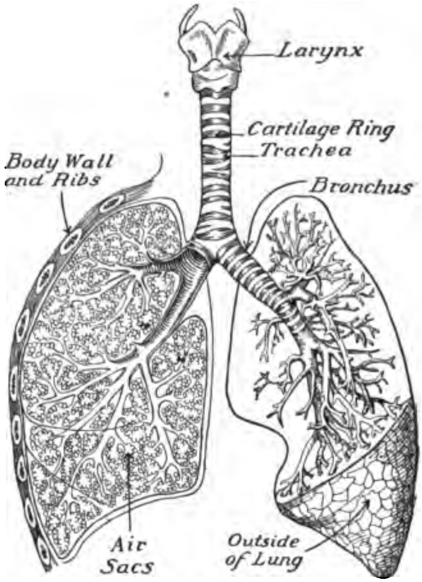

Fig. 41.—The air passages and the lungs. The lung on the left is cut in cross section to show the small air sacs. The lung on the right, with air sacs removed, shows the larger subdivisions of the bronchi.

In the walls of the small sacs are blood vessels, which are separated by a very thin wall from the air in the lungs. It is through this thin wall that oxygen passes from the air to the blood and, in exchange, carbon dioxide passes from the blood to the air.

The Mucous Membranes of the Nose and Throat.—It

has been pointed out in an earlier chapter that the walls of the digestive canal are lined with a peculiar soft moist tissue known as **mucous membrane.** The respiratory passages of the nose and throat are lined with the same kind of membrane.

The tissue cells of this mucous membrane in most parts of the respiratory system are provided with tiny finger-like **cilia** or lashes, which move back and forth, but much more quickly and strongly in one direction (toward the mouth and nose) than in the other. By this motion they sweep along any dust or dirt which has been inhaled and has clung to the moist mucous surfaces, sending it toward the nose or throat, where we get rid of it.

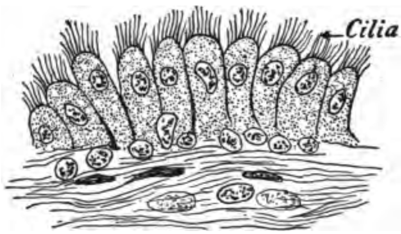

Fig. 42.—Cells of the mucous membrane with their cilia.

Ordinarily this sweeping action of the cilia keeps the mucous membranes free from harmful microbes. When such microbes settle down and grow on the respiratory surfaces, disease may follow. **Colds** and **catarrh** result when the nose and upper part of the respiratory system are affected, **bronchitis** when the germs are in the bronchial tubes, and **pneumonia** if the infection reaches the lungs.

The Organs of Speech.—In the trachea, just below the point where it connects with the throat, is the **larynx** or voice box. Here many of the sounds of speech are made, by the vibration of two bands called the vocal cords, which work somewhat like the strings of a violin. When you talk,

you can feel the larynx move if you place your fingers on your throat just under the chin, at the place where the air passes from the throat into the trachea. A man's voice is deeper than that of a child or a woman because his vocal cords are larger and longer and make a sound lower in pitch. At a certain period in the growth of a boy, his larynx suddenly grows very much larger and the vocal cords lengthen. We say his voice is "changing." Care should be taken not to strain the voice at this time, for it may be seriously harmed.

We do not speak with our vocal cords alone. Many of the sounds are made with the help of the lips, teeth, and tongue. A pleasant voice is one of the most attractive gifts a person can have, and lips, tongue, and larynx can in large measure be trained to produce clear and beautiful speech.

The Process of Breathing.—You have been breathing all your life, some 30,000 times every twenty-four hours, yet you have never had to think about it unless you have perhaps tried to "hold your breath" for a few seconds. It is interesting to know how the body brings about this wonderful rhythmic movement of the air.

Across the bottom of the chest space stretches a sheet of muscle, called the **diaphragm,** which divides the inside of the trunk into an upper and a lower part. It is the upper part or **thoracic cavity** which contains the lungs. The walls of this cavity are supported by the ribs, which slope downward and forward to the breastbone (see Fig. 43). At the back they are attached to the backbone. When the muscles between the ribs contract, the breastbone and the front ends of the ribs are raised; and since they are hoop-shaped, the thoracic cavity becomes larger from side to side and

back to front, as they rise. At the same time, the dome-shaped diaphragm also contracts (pulls downward) and tends to enlarge the central part of the thoracic cavity. All these muscles contract together regularly about twenty times a minute, making the chest space larger at each contraction and smaller at each relaxation.

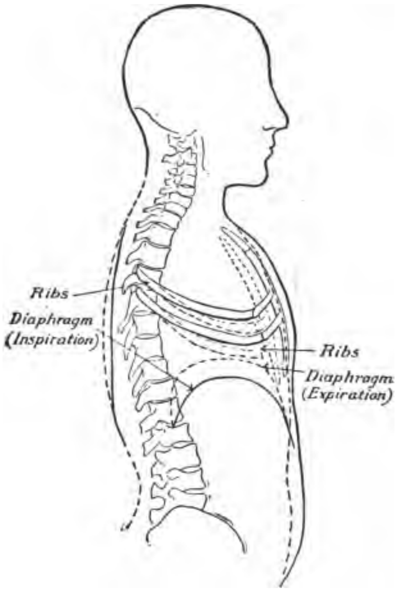

Fig. 43.—Breathing movements of the ribs and diaphragm.

Each time the chest space grows larger, the elastic walls of the lungs stretch so that the lungs fill the enlarged space. More air must, of course, be drawn into the lungs to fill them. This act of breathing in is called inspiration.

At expiration (breathing out), the process is reversed. The chest space is made smaller because the ribs fall back into place, and the diaphragm rises. The chest space is thus compressed, and the elastic walls of the lungs are forced in, so as to drive out some of the air.

This machinery is so wonderfully controlled by the inner adjustment of the body that it supplies just the amount of air the body needs. You know that when you run, you breathe hard and fast. As your muscles work harder, they need more oxygen and form more carbon dioxide, and

without any thought on your part your breathing apparatus adjusts itself accordingly.

How to Breathe Well.—Though the inner machinery of the body takes care that we breathe so as to get the amount of oxygen the body needs, it does not follow that the lungs will keep healthy without care on our part.

When a person slouches in walking, bends over a desk all day, or wears tight clothing that binds the ribs and the abdominal muscles, the chest cannot expand properly. Under such conditions, a person takes short breaths and does not get the air into the deeper parts of the lungs. The portions of the lungs near the bronchi do all the work, and the lower parts, lacking the necessary exercise, are likely to become diseased. This is one reason why clerks and telegraph operators, and other people who sit much of the time in a cramped position, frequently suffer from tuberculosis. In order to have sound, healthy lungs, it is important to form good breathing habits. In walking, standing, and sitting, the head should be held high and the chest out.

Every one pities a narrow-chested man or woman; but scarcely any boy or girl need grow up with a small chest, for it can easily be enlarged by proper position and exercise. You should breathe slowly and deeply; if this is not natural, practice for a little while every day till it becomes a habit. Always breathe through the nose and not through the mouth, because the nasal passages are made in such a way that they warm and moisten the air and strain out its impurities as it is inhaled. Mouth breathing is a bad habit and should be overcome. If it cannot be corrected by a little thought and effort, there may be something wrong which needs medical care.

Adenoids and Tonsils.—Sometimes mouth breathing and difficulty in breathing are due to growths in the throat, and it is important that this condition should be promptly remedied.

Adenoids are finger-like, spongy growths which develop in the back of the throat where the nose opens into it (see Fig. 44). They often get so large as to obstruct the passage from the nose to the throat. Children with adenoids are generally mouth breathers and are apt to have narrow jaws and a peculiar strained expression (see Fig. 45). They are also likely to sleep badly and to wake up crying, and are often irritable and cross and backward in their school studies. Frequently they have trouble with their hearing, and they are likely to catch colds easily and to be slow in getting over them.

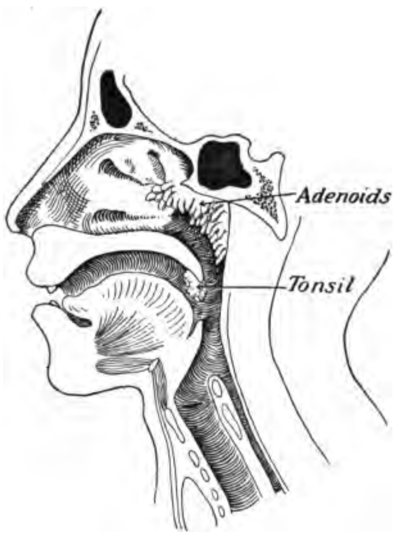

Fig. 44.—Air passages of the mouth and nose.

The tonsils are roundish organs on each side of the throat (see Fig. 44). They often grow to be too large, or become diseased in some way. Bad tonsils are likely to become infected with bacteria and to lead to tonsilitis and other more serious diseases.

It is important for good breathing and for general health

Fig. 45.—The effect of treatment for adenoids upon the general appearance of three children. The upper picture was taken before treatment, the lower, after treatment.

that any unusual growth, like adenoids or over-large tonsils, should be discovered and cured. Many a child is dull in school and fretful and unhappy because of such a condition. The whole disposition of such a child changes when the trouble is removed by a safe and simple operation. It has been found that about one child in ten has either adenoids or tonsils that should receive medical attention.

Effects of Smoking.—The habit of smoking always results in injury to the air passages, and a cough and "smoker's sore throat" are often caused by the use of tobacco. Inhaling, or taking the smoke into the lungs, is a particularly dangerous habit, since in this way the poisons in the smoke pass directly into the blood and thence to all parts of the body. One of the reasons that cigarette smoking is so harmful is that the smoke of a cigarette, being milder than the smoke from a pipe or a cigar, is much more likely to be inhaled.

Questions for Discussion and Review

1. What facts do you know about the air?
2. Hold your nose and keep your mouth tightly shut. How many seconds is it before you are uncomfortable? Why?
3. How long can you stay under water in a dive?
4. Why do we need oxygen?
5. We hear stories of lowering a lighted candle into a well or unused cellar before any one dares to go down. What is the object?
6. What waste product of bodily activity is thrown off by the lungs?
7. Name the organs of respiration through which the air passes to get into the lungs.
8. Explain how the air and the blood exchange oxygen and carbon dioxide in the lungs.

9. What becomes of the dust in the air we breathe?

10. What is a cold in the head? Bronchitis? Pneumonia?

11. How is the voice produced?

12. What causes a boy's voice to become deeper when it "changes"?

13. Say the different letters of the alphabet and see which do, and which do not, require the use of the teeth and tongue.

14. What muscle separates the thoracic and abdominal cavities? What part does this muscle play in the process of breathing?

15. How is the chest enlarged to allow the air to enter the lungs?

16. How is the air forced out of the lungs in respiration?

17. Watch the breathing of some of the people you know. Do you think they use *all* of their lung tissue?

18. What habits may interfere with deep breathing?

19. If you saw a child who kept his mouth open most of the time and gasped for breath after closing it for a few minutes, what would you conclude was the matter?

20. Take a hand glass and try to locate your tonsils. Are they pink or red? Which should they be?

CHAPTER X

THE CIRCULATORY SYSTEM

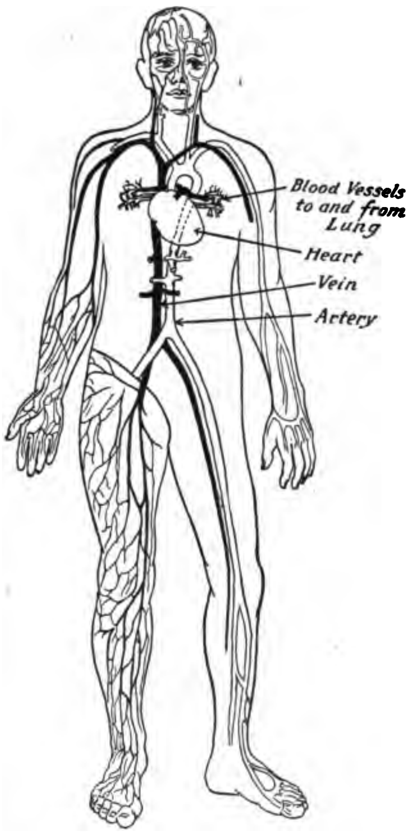

Fig. 46.—The circulatory system.

The Function of the Circulation.—The food that is absorbed from the intestines, and the oxygen that is taken in through the lungs, must in some way be carried to all parts of the body. It is the task of the blood, flowing through the circulatory system, to bring these necessary substances to muscles, skin, brain, and all the other organs. We may well speak of this fluid as "the life-blood."

The living parts of the body are changing all the time, building up new tissue out of the food and "burning up" both living matter and lifeless fuel material by the action of oxygen. These activities, as we have seen, are constantly producing waste materials—carbon dioxide and other things—

which, if they are not eliminated, poison the body. These waste products must be carried away from the tissues; and it is again the blood which does this work.

The Blood Vessels: Arteries, Veins, and Capillaries.—The blood flows inside a system of tubes, the **blood vessels,** which have many branches and go to all parts of the body. These blood vessels may be compared to the streets of a city, the routes by which everything passes from one place to another. Through the streets, the grocery wagons and the milk wagons come to deliver food, and the garbage wagons and the ash carts take the waste away from the houses. In somewhat the same way, the blood flows through the blood vessels, carrying food to the tissues and taking away their waste products.

The system of blood vessels starts from the heart, passes through all parts of the body, and returns to the heart again. The blood vessels that run out from the heart are called **arteries.**

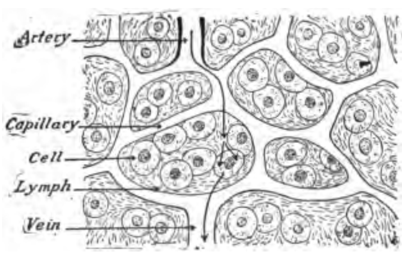

Fig. 47.—How the substances in the blood reach the tissue cells.

The arteries subdivide, at their ends, into numerous tiny branches called **capillaries,** which form a fine network all over the body. Wherever you prick or cut yourself deeply, you are sure to strike a capillary, from which the blood will flow.

These capillaries unite to form larger vessels, the **veins,** which bring the blood back to the heart. The walls of the capillaries are much thinner than the walls of the blood vessels, and through these thin walls the food and

other things in solution may pass to and from the tissues.

The Blood: Red Corpuscles and Plasma.—The liquid part of the blood is not red, but a pale straw color; it is called the **plasma.** Its redness, as we see it, is due to great numbers of **red corpuscles** (kôr′ pŭs'ls) floating in it. These red corpuscles are of a disc shape and so small that there are millions in each drop of blood. They are living cells, and contain a substance called **hemoglobin,** which unites very readily with oxygen and carries most of the oxygen from the lungs to the capillaries. The red cells contain more of the element iron than most tissues. It is said that a French physiologist used to exhibit in his lecture room a lump of iron which had been extracted from great quantities of blood.

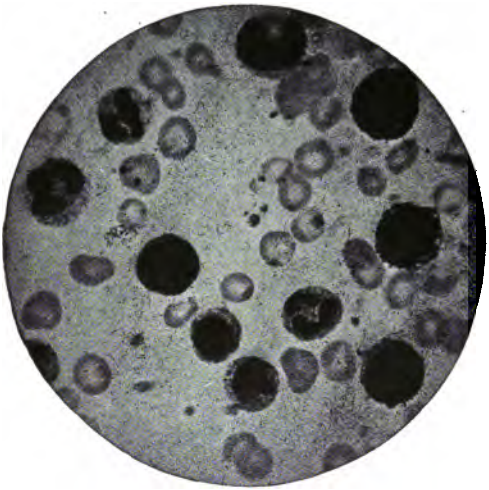

Fig. 48.—Types of cells in the blood. The lighter circles are the red cells; the large, darker ones the white cells. They look dark, not white, because they have been stained, for photographic purposes, with a dye which stains their large nuclei. The white cells would be relatively much less numerous in the blood itself.

If a drop of blood is set aside for half an hour under an inverted tumbler, the substances in it will separate and you

will see a little mass of red corpuscles, mixed with a peculiar fibrous substance, floating in a yellowish liquid, the plasma. This separation is called clotting or **coagulation.** The clot or mass of solid matter which forms in this way is what stops the flow of blood from a small cut in your finger.

The "flesh color" of the skin is due to the many fine blood vessels in it. When the blood contains too few red blood corpuscles, as in certain diseases or in cases of underfeeding, a person may become very pale in appearance. Such a condition is called **anæmia** (*ȧ* nē′ mĭ *ȧ*).

In addition to the red corpuscles, the blood contains a much smaller number of white corpuscles, having their own special duties, which will be discussed later.

The Lymph.—The arteries, veins, and capillaries, as we have seen, form practically a system of closed tubes, and the exchange of oxygen and food, of carbon dioxide and waste products, takes place through the delicate walls of the capillaries. How do the oxygen and food reach the tissue cells themselves, the living units which make up the tissues between the capillaries?

This final contact with the cells is brought about by means of another fluid called the **lymph,** which is found all through the body, bathing its tissues (see Fig. 47). A large part of the lymph is made up of blood plasma which has passed through the walls of the capillaries; and it also contains waste products given off from the cells. If you scrape the back of your hand a little, but not deeply enough to draw blood, a yellowish fluid oozes out; if you burn yourself, a yellowish fluid gathers in the blister. This is the lymph.

The lymph is not a stagnant fluid but is in constant, although very slow, motion. Plasma is always passing out through the capillary walls into each organ of the body, and

there must be some way for it to get back to the blood system again. This it does by means of a second system of tubes or ducts, called the **lymphatics,** which collect the lymph from the various organs and carry it to larger and

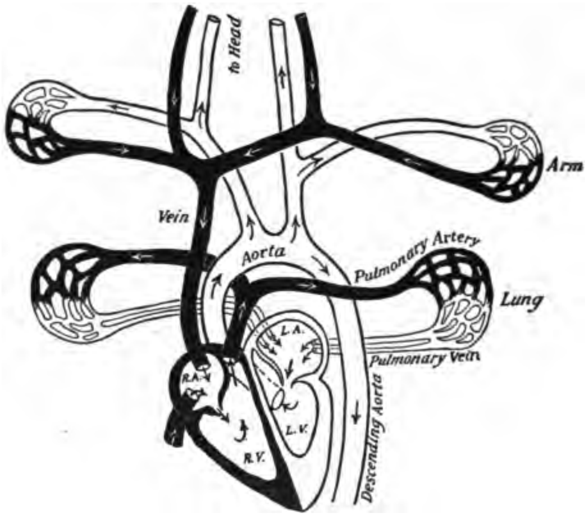

Fig. 49.—The heart and some of its chief blood vessels. Blood containing oxygen indicated in white; blood poor in oxygen, in black. R. V. right ventricle, R. A. right auricle, L. V. left ventricle, L. A. left auricle.

larger lymphatics, which finally discharge into the large veins opening into the heart.

The Heart.—Did you ever wonder why we speak of learning something "by heart" or why pictures of hearts on a valentine are a sign of affection? Learning and loving belong to the brain rather than to the heart, but the heart is such an essential organ of the body, and such an active one, that it has come to stand for life itself.

The heart is the most important part of the circulatory system, the pump which, by its rhythmic contraction, drives

the blood through the blood vessels to all parts of the body. It is a "heart-shaped" mass of muscle, about the size of a man's fist, lying between the lungs. You can feel it beating (expanding and contracting) all the time, night and day, if you put your hand on the left side of your chest.

The General Course of the Blood.—The heart is divided into halves, and each half is divided into an upper part or chamber, the **auricle,** and a lower chamber, the **ventricle.** From the right half of the heart, a large artery, the **pulmonary artery,** carries the blood (which has just returned from

Fig. 50.—The principal blood vessels of the foot.

the tissues and has given up its oxygen to them) to the lungs. There the blood gets a new supply of oxygen, and large veins bring it back from the lungs to the left side of the heart. The blood, rich in oxygen, now passes out from the left side of the heart by a large artery, the **aorta** (ā ôr′ tȧ), nearly an inch in diameter. It goes through the smaller arteries to the capillaries, thence to the smaller veins, and is finally brought back through the large veins to the right side of the heart, where the cycle begins again.

If you follow out this course, you will see that in the arteries (except the pulmonary artery) and the capillaries

the blood is rich in oxygen, which it is carrying to the tissues. In the veins, on the other hand (except the vein coming from the lungs), it has given up most of its oxygen and has become loaded with carbon dioxide.

Blood on its way out to the tissues, rich with its gifts of oxygen, is bright red, like the capillary blood which flows when you cut your finger. Blood on the way back, after

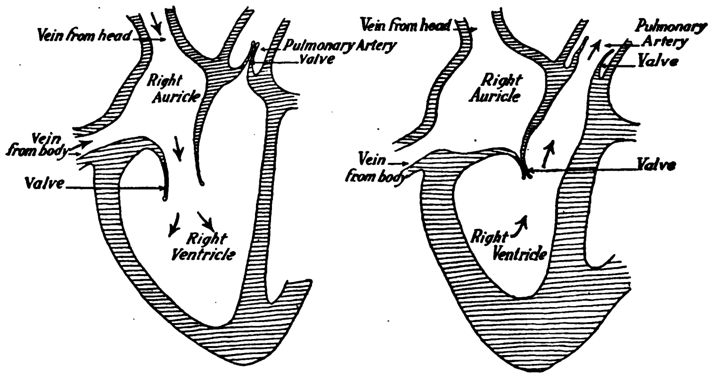

Fig. 51.—The valves of the heart, when the heart expands (left) and when it contracts (right).

giving up its oxygen, is of a darker purplish red, almost blue, as in the veins in the back of the hand.

The Valves of the Heart and Veins.—The blood flows out through the arteries (not through the veins) when the heart contracts; and it flows in from the veins (not from the arteries) when the heart expands. This is due to the arrangement of the little flaps or **valves** located between the auricles and ventricles, and at the places where the arteries leave the heart (see Fig. 51). The valves of the first set open downward, so that when the heart expands they open and allow the blood to flow down into the ven-

tricles. When the heart contracts, they close again and the valves into the arteries open upward, so that, with the contraction of the heart, the blood is pushed out into the arteries. When the heart expands, the valves at the arteries close again and the valves between auricle and ventricle open. In the veins, there are similar valves which allow the blood to flow toward the heart but not in the other direction.

The Working of the Circulation.—The fact that the blood circulates from the heart to all parts of the body and back again, was discovered in 1621 by a famous Englishman named William Harvey. Harvey (1578–1667) was Court Physician to Charles I, and it is said that being placed in charge of the king's children at the battle of Edgehill, he sat with them under a hedge calmly reading a book all through the fighting. Through his discoveries, he became the greatest figure in the history of physiology.

It seems curious to think that only three hundred years ago scientific people believed that the blood flowing into the heart by the veins all came from the water and food taken in through the alimentary canal, that the expansion of the heart sucked this in, and that some kind of suction exerted by the tissues drew it out through the arteries. The great volume of blood flowing into the heart should have shown that this explanation was absurd; but it was Harvey who first convinced physicians and physiologists that the blood flowing out through the arteries is the same blood which comes back again through the veins—in other words, that there is a true *circulation*.

This circulation of the blood is one of the most wonderful of the many wonderful things which take place within our bodies. The whole of the blood (in an adult man about

twelve pints) may complete its round through the body in from twenty to thirty seconds. At that rate, it makes the circuit more than three thousand times a day. Night and day, year after year, "this river of life," as one writer has

Fig. 52.—Harvey demonstrating the circulation of the blood to King Charles the First.

said, "is impetuously rushing through every part of the body, by means of an elaborate network of canals."

The chief force that carries on this work is the beat of the heart, which is produced by the contraction of its muscular walls. The blood vessels themselves, however, also play an active part in the process of circulation. Their walls, particularly those of the arteries, are elastic, and they press on the blood and help to drive it farther and farther into the smaller blood vessels. With a rubber bulb, filled with water

and connected with a rubber tube, you can imitate this action. When you press on such a bulb, you force the water into the tube, making it bigger; but the tube itself tends to contract and press the water onward. Each squeeze on the bulb sends a wave of pressure along the tube. This is just what happens in the circulation. Each beat of the heart causes a wave of pressure to pass along the arteries.

By placing the finger gently on a large artery, such as the one in the wrist, you can feel these changes in pressure, which we call the **pulse.** Each pulse beat corresponds to a beat of the heart. In grown men there are about seventy pulse beats a minute, and in women about eighty. In children the pulse beats more rapidly.

How the Heart and Blood Vessels Meet the Changing Needs of the Body.—When a muscle is working actively, it needs more food and oxygen and has more waste to get rid of than when it is at rest. The same thing is true of every part of the body.

If, for instance, a person who has been lying down rises to a standing position, the muscles have more work to do in holding the body erect, and the heart meets this need at once by beating a little faster. If you run or play hard at any game, your heart beats a good deal faster, to supply extra blood to the muscles. You can easily notice that your pulse rate increases during active exercise.

It is not only the heart beat, however, that varies to suit the changing needs of the body. The amount of blood which goes to any special organ depends largely on the contraction or expansion of the walls of the arteries leading to it. When more blood is wanted in a particular place, the muscles of the walls of the smaller arteries relax and their fine branches grow bigger, so that more blood reaches that particular

organ. After a meal, for instance, the stomach and intestines are working hard and need more blood, and the blood vessels in those parts of the body expand to supply the need. It is hurtful to take exercise just after meals, because exercise draws the blood to the muscles and away from the digestive organs. It is because the blood is largely in the digestive organs, and the amount flowing through the brain is lessened, that we often feel sleepy after eating.

The way in which the blood vessels change in size is well illustrated by the act of blushing. Embarrassment causes a dilation of the blood vessels of the skin, and the face becomes flushed, as a result.

The Temperature of the Body and How It is Controlled.—When you go from a hot room into a cold one, your body *feels* colder. In reality, it is only the surface of the body which changes its temperature. As long as you are in good health, the temperature of the body below its surface stays very close to 98.6° Fahrenheit, whatever the temperature is outside. In the Tropics the air temperature may rise above 130°, and in certain factories, iron foundries, and glassworks it may for a time be even higher. In Arctic regions it may be nearly 100° *below* zero. Yet through a range of more than 200° difference of air temperature, the body temperature remains the same. At the North Pole with Peary or in the depths of the Brazilian forests with Roosevelt, the thermometer placed under the tongue of a man in good health would register close to 98.6°.

The higher animals, such as cats and dogs and birds, all maintain their bodies at a constant temperature in this way, and as the temperature is usually higher than that of the air about them, they are called **warm-blooded** animals. Fishes, frogs, insects, and the like are called **cold-blooded,**

though what is really meant is, not that they are cold, but that they take on the temperature of their surroundings.

It is mainly by changes in the *distribution of blood* between the surface and the inner parts of the body that the general temperature of the human body is kept uniform. The life processes are constantly producing heat, and this heat is constantly given off from the surface of the body to the air about it. When the air is cold, the body will lose heat rapidly; but when it is warm, the body, in order to keep its temperature at 98.6°, must find some special way of giving off its surplus heat. This it does largely by an *increase* in the size of the *skin blood vessels*, so that more blood will go to the skin, to be exposed to the cooling influence of the air.

If you pass from the cold street into a hot room, your face becomes flushed. This is because the blood vessels in the skin have expanded so as to bring more blood to the surface to be cooled off. In a cold room, on the other hand, the blood in the skin would cool very rapidly and the vessels contract so as to prevent too much chilling.

The fact that the nerves control the blood vessels of the skin in this way was another of the discoveries which developed from the work of the French physiologist, Claude Bernard. He found that if the nerves running to a certain part of the body were injured, the part would become flushed and hot. It was finally shown that this heating was due to the expansion of the blood vessels, which let an excess of blood into the tissues, and that the vessels expand in this way whenever the muscles in their walls are not controlled by the nerves.

A second important aid in keeping the body cool—which comes into play particularly when the atmosphere is hot—

is the sweat, or perspiration, which is poured out from tiny glands in the skin. When perspiration is produced very rapidly, it collects on the skin, but even when the skin does not feel moist, there may be perspiration forming and evaporating into the air just as fast as it is formed. The evaporation of this moisture makes the skin cooler, just as your finger feels cool if you wet it and hold it up in a breeze. This is the reason that we are so much more comfortable on a dry hot day than on a moist hot day, for the sweat cannot evaporate freely when there is much moisture in the air. Dogs and other animals sweat very little. On a hot day they can relieve themselves only by violent panting, which draws cool air into the lungs and increases evaporation from the surfaces of the lungs and of the nose and mouth passages. In our own case, when it grows hot outside, or when we exercise and produce a great deal of heat in the body, the secretion of sweat increases; when it grows cool, the secretion diminishes.

The Circulation and the Body Temperature in Illness.—A good healthy circulation is one that meets all the changing conditions of life quickly and easily. When the heart, or the muscles in the walls of the blood vessels, or the nerves which control them are not working properly, we say a person has a poor circulation; such a person's hands or feet may grow cold very easily, and he may also be very sensitive to heat.

In many illnesses, the complicated machinery of the circulatory system can no longer do its work successfully. In certain diseases the heart beats faster than it should—in others, more slowly. In some diseases its beat is weak and irregular. The feeling of the pulse is often a great help to the physician in finding out what is wrong. Its rate, which

is the same as the beat of the heart, can be observed, as well as the evenness of the beats and the amount of force with which the blood is pressing on the walls of the vessels. Of course, the pulse varies greatly even in perfect health—as during exercise—and only a physician can tell whether or not a particular condition of the pulse indicates anything wrong.

In many kinds of illness the temperature machinery of the body is upset. The temperature may rise above 98.6° or fall below it. When it reaches 100° or more, the condition is known as **fever**. It is a good plan to have, in every family, a clinical thermometer. When any one, child or grown person, feels indisposed, the temperature should be taken; and if the thermometer records a temperature over 100°, the patient should stay indoors and the doctor should be sent for.

Effects of Alcohol upon the Circulation.—People sometimes take alcoholic drinks to warm themselves when they are chilly. What alcohol does in such a case is to dilate the skin blood vessels and make the person feel warmer because the skin, where the nerves of feeling are, is warmer. But the presence of so much blood in the skin means a more rapid loss of heat and a consequent chilling, rather than a warming of the body as a whole. As we shall see later, alcohol is not really an effective stimulant.

The delicate machinery of the heart and blood vessels is easily and seriously injured by alcohol and other poisons. The heart muscles in persons who use alcoholic drinks are likely to become flabby and weak, so that they are not able to do their work when special strain is put upon them.

When people grow old, lime collects in the walls of the arteries and causes them to become hard and stiff, much as

the bones become richer in mineral matter with advancing age. Such arteries, instead of being soft and elastic like a new rubber tube, become brittle like old dry rubber, and can no longer respond quickly to the needs of the body. Many of the diseases from which old people suffer are due to this "hardening of the arteries." Alcoholic drinks, the poisons which are formed during an attack of a communicable disease, and the poisons which are absorbed from bacterial decay in the intestines, all help to injure the walls of the blood vessels and bring on hardening of the arteries long before normal old age should set in. When the arteries harden in this way, it takes more force to pump the blood through them. The heart is often weakened by such overwork, so that it is not able to withstand strains such as those put upon it by serious illness.

Effects of Tobacco upon the Circulation.—Tobacco also exerts harmful effects on the heart and the circulation. Even the moderate use of tobacco causes shortness of breath, which is really due to poor heart action. When smokers have "poor wind", it is because their hearts cannot pump the blood fast enough to supply the oxygen needed by their muscles, and the lungs have to do extra work to make good the deficiency. The disease called "tobacco heart" is another well-recognized result of smoking. In this disease the heart beats very weakly and irregularly.

It may easily be seen that such disturbances of the heart and circulation seriously affect the best working of the whole body. Experience shows that smokers are much less likely to be successful in athletic competitions than those who do not use tobacco. Professor F. J. Pack reports that of 93 smokers who tried for places on six different football teams, only 31 "made the team"; while of

117 non-smokers, 79 were successful. That is, only 33 per cent of the smokers secured places on the teams, as against 68 per cent of the non-smokers. Tobacco is, of course, always forbidden to athletes in training.

QUESTIONS FOR DISCUSSION AND REVIEW

1. By what process do digested foods get from the intestines to the tissues which they build or repair?
2. By what means are the waste products of the tissues carried away?
3. What are blood vessels? How many kinds of blood vessels can you name? How do they differ?
4. Compare the blood vessels with the streets of a city.
5. Imagine that you are looking at some blood through a microscope. What would you see?
6. What gives the red color to blood?
7. What part of the blood carries the oxygen?
8. What is the advantage of the clot which forms when blood comes in contact with the air?
9. Would you suppose that an anæmic person got as much oxygen from the air as a rosy person?
10. What is the special work of the lymph?
11. Where does the lymph come from and where does it go?
12. Are lymph and blood at all alike? How do they differ?
13. Why is the heart such an important organ?
14. Of what kind of tissue is the heart composed?
15. How is the heart divided?
16. Outline the course of the blood from the time it leaves the heart till it returns.
17. How does the blood in the aorta differ from that in the big veins emptying into the heart?
18. What prevents the blood from flowing backward when the heart contracts? Where else in the circulatory system do we

find a similar arrangement? Do you know of any pieces of machinery which work in the same way?

19. Who discovered the true facts of the circulation of the blood? Of what value do you think this discovery has been?

20. What kind of walls do we find in the arteries? How do they help the work of the heart?

21. How many times a minute does the heart beat?

22. Count the pulse of one of your schoolmates, using the second hand of a watch. Have him run up and down a flight of stairs, and then count his pulse. Make him lie down a few minutes and count again. How do you explain the variation?

23. How is the amount of blood in the different parts of the body controlled?

24. Why is it difficult to study after a hearty dinner? Why is it dangerous to play a hard game of ball just after dinner?

25. What is the normal temperature of the body? What is a fever? Does the temperature ever go below normal?

26. How is the temperature of the body controlled so that it is the same in all climates?

27. What makes one's face red after violent exercise? On a hot day?

28. What is the difference between a cold-blooded and a warm-blooded animal? Which is man?

29. Where does the heat of the body come from?

30. How does the body get rid of the extra heat?

31. In warm climates, people cool water bottles by covering them with a wet cloth and hanging them in the breeze. Explain. Compare with your body.

32. Why do we drink more water in hot weather than in cold weather?

33. In what ways do alcohol and tobacco affect the circulation?

CHAPTER XI

AIR AND HEALTH

Fig. 53.—No indoor ventilation is quite so good as the ventilation of the woods and fields.

Good Air and Bad Air.—The air of a closed room with many occupants is different in a number of ways from fresh outdoor air. The people in the room, by their breathing, have taken oxygen out of the air and given off into it carbon dioxide. Gas flames or lighted lamps also cause a decrease of oxygen and an increase of carbon dioxide. In the air of a crowded, poorly ventilated room, moreover, there is almost always a stale smell, which the people in the

room may not notice after they have become used to it, but which any one coming in from outside notices at once. This smell comes from the mouths and bodies and clothes of the people.

The human body gives off not only carbon dioxide and these ill-smelling substances, but also heat and moisture. On the average, each person produces about as much heat as a candle flame; and the lungs and the skin together give to the atmosphere about three pints of water a day. If there were a candle burning in every seat in the schoolroom, the room would soon get warm; and so it does when there is a child sitting in each place, unless the heat is somehow carried away.

Both the heat and the moisture given off by the body are greatly increased by exercise, since the muscular work produces more heat, and the sweat glands form more perspiration to keep the body cool. It has been shown that a vigorous walk may cause an increase in heat production of 1000 calories and an increase in evaporation of 800 grams. After a hard game, you generally want a drink of water to make up for the water lost in this way.

The Effect of Chemical Substances in the Air on Health.— It used to be thought that the air of a crowded room was bad because of its lack of oxygen and excess of carbon dioxide. Men who go down into mines or deep pits in the ground sometimes die because of lack of oxygen, just as a candle goes out in a closed space. This danger never arises, however, in an ordinary room even when it is most crowded. Oxygen and carbon dioxide pass easily through cracks and even through walls and ceiling where there are no visible cracks, and there is never so little oxygen or so much carbon dioxide in a room as to harm any one.

The odors in the air of a close room are unpleasant, and experiments indicate that stale air has an unfavorable effect upon the appetite. It is important for the sake of health and decency that the air of schoolrooms and living rooms should always be kept fresh and free from unpleasant odors.

The Effect of a Warm Atmosphere on Health.—The worst thing about the air of a close room is its heat and, sometimes, its excess of moisture. A crowded, badly ventilated room is almost always a hot room, since human bodies produce heat and moisture as well as carbon dioxide. In such a room, the blood vessels in the skin expand and the blood goes to the surface of the body to cool off, as may be seen by the flushing of the face. The body temperature rises, the pulse goes up, and the blood pressure falls. As the blood moves to the outer surface of the body, the brain and other inner parts are robbed of blood, and one feels dull and listless and has little desire to work or play. In studies made by the New York State Commission on Ventilation, it was found that men did 15 per cent less work at 75°, and 37 per cent less work at 86°, than at 68°.

People who live in overheated rooms are likely to catch cold and to have other illnesses. In such people, the mucous membranes of the nose are constantly congested (filled with blood and lymph), as the blood vessels dilate to keep the body at the proper temperature. As a consequence, these membranes—instead of shrinking and drying promptly, as they should, when they come in contact with cold outer air—lose their quickness of response and stay moist and swollen after the blood vessels themselves have contracted; this makes them an excellent breeding place for bacteria. People who have been weak-

ened in this way are very sensitive to the cold air and are easily subject to chills. Benjamin Franklin once said, "People who live in the forest, in open barns, or with open windows, do not catch cold, and the disease called a cold is generally caused by impure air, lack of exercise, or from overeating"; and he was right.

The Value of Moving Air.—There is a great difference in the effect of still air and moving air, even when the general temperature is the same. The body is constantly giving off heat, and if the air is quiet, the portion close around the body will soon get much warmer than the rest, as if the body were surrounded by a kind of blanket of hot moist air. A wind breaks up this layer and brings fresh cool air to the body all the time; this is why it is so much more comfortable outdoors, or with an electric fan running, than in a closed room with still warm air.

Effects of Cold Air.—Moderate cold is a good thing for the body. It deepens the breathing, stimulates the blood vessels, and makes one feel active and vigorous—if the cold is not too great and does not last too long. Excessive cold is as bad, however, as excessive heat. Unless well wrapped up, it is dangerous for those not specially "hardened" to it to sit down or lie still in a room that is really chilly. Drafts, or local currents of cold air, on a particular part of the body seem to be especially harmful. It is most unwise to sit or stand in a cool place after you have been exercising hard and are flushed and moist with perspiration.

Chilling the body makes it less able to resist disease. If there happen to be germs of any kind in your nose or throat, the weakening effect of a chill may be just enough to give them a chance to grow and cause illness.

Effects of Atmospheric Humidity.—From what has been said in the last chapter, it will be obvious that on a hot moist day we feel more uncomfortable than on a hot dry day, because moisture interferes with the cooling effect of the evaporation of perspiration. At low temperatures the effect of moisture is quite different. When the air is cool, little perspiration is formed, and its evaporation is a small factor compared with the direct cooling caused by the cold air. This direct cooling will be favored by a humid atmosphere, since moisture collecting in the clothing increases its power of conducting heat. So it is a curious fact that humidity in the air makes a hot day hotter and a cold day colder.

Hot moist air is found in very crowded rooms and in certain factories, but most of our rooms in winter are hot and dry. The warmer the air is, the more moisture it can carry, and when we raise the temperature of cold air from outdoors to 60° or 70° without adding any moisture to it, it will become relatively much dryer or more ready to take up moisture.

Watching the Thermometer.—Unless children are provided with especially warm clothing, such as is used in open-air rooms, a temperature between 65° and 68° is generally right for the classroom. Every schoolroom and every living room should have a thermometer in it. It is a good plan in the classroom to have a pupil appointed each week to act as Health Officer and keep a record of the temperature hour by hour. When the thermometer gets to 70°, the windows should be opened to cool the air; for whenever the temperature is above 70°, the work of the children will be affected and their health is likely to be injured.

Dusts and Poisons in the Air.—The ordinary fine dust in the air, which you can see as tiny flecks dancing in the sunbeam, does no harm. When a great cloud of dust is stirred up in sweeping, however, or when clouds of dust are whirled along by the wind in the street, there is real danger that any disease germs present may be carried and breathed

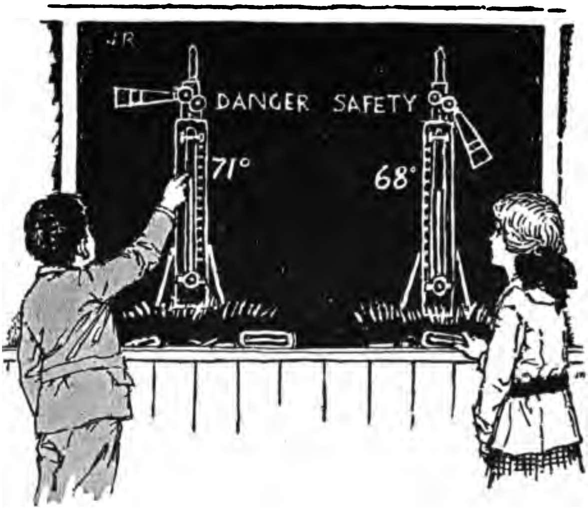

Fig. 54.—The danger signal. What is the temperature of your classroom?

into the nose or the mouth. This is why classrooms and corridors should never be swept when the children are in them. When you are on the street in a dust storm, keep your mouth shut so as to take in as little of it as possible.

The danger in breathing quantities of dust is not, however, so much in the germs that the dust may contain as in the hard particles themselves, which may hurt the delicate lungs. Men who work at certain dusty trades, like steel

grinding and granite cutting, easily fall victims to tuberculosis because their lungs have become injured by the inhaling of hard dust.

In other industries, such as white lead making and rubbing down paint, there are poisonous dusts or gases which may get into the air and do much harm. The only

Fig. 55.—A dusty trade. Breathing fine particles of mineral or metallic dust predisposes to tuberculosis.

poison likely to be found in the air of houses is illuminating gas from leaking fixtures or from leaking or carelessly handled gas stoves. If there is the least smell about gas fixtures or stoves, or if the cocks are too tight or too loose, the gas man should be sent for; and great care should be taken not to leave cocks turned on unlighted or gas so low that it may blow out. A gas oven should never be lighted unless the door is wide open, because if, by any chance,

gas has been escaping into the oven an explosion may occur.

What We Mean by Good Air.—Good air means air free from poisons or appreciable dust or objectionable odors. Above all, it means air that is not too warm or too cool and, if possible, in moderate and pleasant motion.

Heating and Ventilation.—Since cool, clean, fresh air is necessary for health, it is very important that the rooms in which we live and work should be well ventilated. **Ventilation** means a change of the air, or a supply of cool fresh air to take the place of that which has become stale and heated. About thirty cubic feet of fresh air per minute must be brought into a room for each person, in order that the bodily heat may be carried off and the air kept fresh and free from smell.

In warm weather and in a crowded room, where the heat from many bodies is considerable, overheating is the chief problem, and the air that enters should be cooler than the air in the room, so as to take up the excess heat. In cold weather, if a building has a system of **direct heating** by stoves or radiators in the room itself, the heating effect should be sufficient to balance the cool air admitted for ventilation. Some buildings are kept warm in winter by **indirect heating,** with warm air from a furnace or from a mechanical ventilating plant. In this case, the warm air sent into the rooms through the registers serves for both heating and ventilation, and should be at just the temperature, and in just the amount, to balance heat loss through the walls and yet keep the air of the room below 70°.

Methods of Ventilation.—The simplest way to get fresh air is to open the windows. Cold air is heavier than warm air and tends to fall, while warm air tends to rise. If a

window is open at top and bottom and if it is cool outside, the warm air of the room will pass out at the top of the window, while the cool air from outside will enter at the bottom. If the wind is blowing, it may be a great aid in ventilation.

The trouble with window ventilation in winter is that the outside air is so much colder than the air indoors that it makes a draft near the windows, and persons sitting near

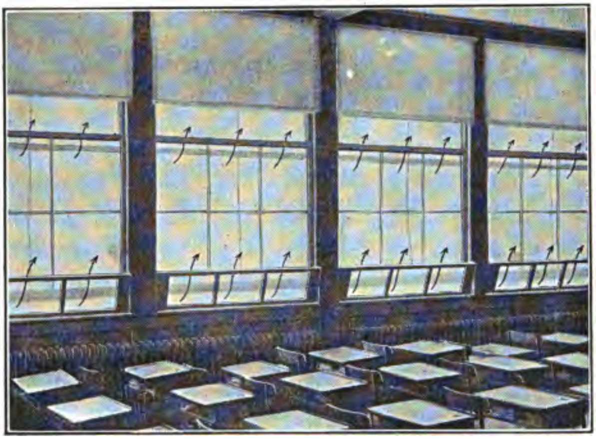

Fig. 56.—A window-ventilated schoolroom (Fairfield, Conn.). Notice the plates which deflect the air upward, and the long radiators under the windows.

them become too cool. Such drafts may be partially avoided by the use of sloping boards or glass plates made to fit into the bottom of the window, which direct the cool air upwards where it mixes with the air of the room. In very cold weather, a vertical board may be placed under the lower sash so that air comes in only between the sashes.

In some of the best schools, the ventilating and heating arrangements include sloping window plates, like those shown in Fig. 56, to direct the air upward; large radiators

along the wall under the windows to warm the air somewhat as it comes in; and ducts leading from near the ceiling out through the roof, to carry off the warm air which rises to the top of the room.

In small schools heated by stoves in the classrooms, the air often gets very stale if the windows are closed, while there are drafts if the windows are open. A supply of fresh, but not too cold, air can be obtained, in such cases, by having a jacket around the stove with pipes leading in from the outer air to the lower part of the jacket. The heat of the stove will make an up-current and draw in fresh air through these pipes.

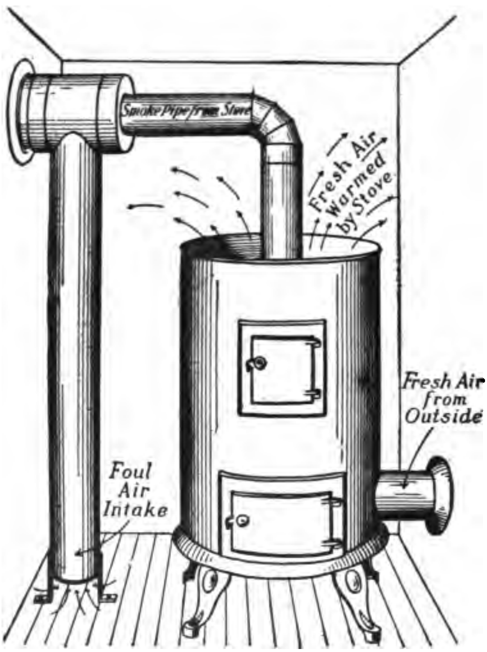

Fig. 57.—Ventilation of the schoolroom by means of a jacketed stove.

In larger school buildings, we usually find a system of indirect heating, fresh but warmed air being supplied by a mechanical ventilating system. This consists of a set of large ducts to bring warmed fresh air to each room and another set of ducts to take stale air out of each room, the air being driven through the ducts by revolv-

ing fans. Often this system is combined with radiators in the room, the system of heating then being called **direct-indirect.**

Whatever the ventilating system may be, it is a good plan to open all the windows now and then and take a little vigorous gymnastic exercise. The change to a low temperature for a few minutes makes you feel brisk and wide-awake, and the exercise makes the heart beat faster and the lungs take in more air. By exercising, you make sure that the body does not become chilled by the change in temperature.

Fig. 58.—A simple outdoor sleeping porch.

Outdoor Life.—There is nothing quite so good as life out of doors. If you are to grow up to be as healthy as possible, you should be out of doors all you can. The wind breaks up the layer of warm air that clings close to the body, and the constant slight changes in temperature keep the skin in good condition, by stimulating its blood vessels and nerves so that they can quickly adjust themselves to changing conditions.

Fresh Air in the Bedroom.—It is especially important to have plenty of air in the sleeping room. Windows should be open at night, even in cold weather. Many people find that

they grow stronger by sleeping on a porch in the open air. One should always take care, however, that there are enough covers on the bed to keep the body perfectly warm. It is dangerous to become chilled in sleeping.

Questions for Discussion and Review

1. What is *good air?* Is the air better in the city or in the country? On a hilltop or in a hollow?

2. What changes take place in the air of an ill-ventilated, occupied room?

3. Why is the air at a moving picture show almost always bad? Why is it worse there than at a circus, where there are usually more people?

4. Why does bad air make one sleepy?

5. In sweatshops in some of the larger cities, the workers sew all day in poorly ventilated, over-crowded rooms. Would you expect the workers to be strong, rosy, and well-grown? Explain.

6. In reports of Peary's Arctic journeys, it is said that the men had no colds until they returned to civilization. Explain.

7. Why do we have more colds in winter than in summer?

8. Which do you like better, a still day at 80° or a windy day at 90°? Why?

9. Find out what you can of the *punkahs* in India. Why are they necessary?

10. Why is one likely to get chilled in going from an overheated room into the cold, or standing in a draft when one is very warm from exercise?

11. Why is dust dangerous? The most up-to-date equipment in schools and offices calls for vacuum cleaners. Explain.

12. Why have big factories found it more economical, as well as more humane, to provide large, well-ventilated, well-lighted workrooms for their employees?

13. What trades do you know which are dangerous to the

lungs because of fine substances in the air, which are inhaled by the workers?

14. How much air is needed for ventilation in your schoolroom?

15. Find out how your schoolroom is ventilated; whether by a mechanical system or by windows only; where the air comes in and goes out; and whether the system works well, so that the room never has a higher temperature than 68° and never gets stuffy and stale-smelling.

16. Explain what is meant by direct, indirect, and direct-indirect heating.

17. In the ventilation of a schoolroom, where would you place the inlet for fresh air and the outlet for stale air?

18. In many rural schools the only heat is from one big stove, and the only ventilation is at the windows. What are the drawbacks to this system? How may the system be modified?

19. Why do we exercise or play a game while the schoolroom windows are open to air the room?

20. There are many more open-air schools now than there were five years ago, and their number is increasing. What advantage have they over ordinary schools?

CHAPTER XII

THE WASTES OF THE BODY

Waste Materials.—The chemical changes in the body have been compared to what goes on in a furnace, where coal is burned and heat is given off to warm a house or to run an engine. As a result of the burning of fuel in the furnace, certain waste materials are formed—unburned clinkers, ash, and gases. The clinkers and ash drop into the ash pan and are removed; the gases pass off by way of the chimney. So in our bodies, as a result of the oxidation or "burning" of the food, waste products are formed. The carbohydrates and fats become carbon dioxide and water. The proteins change into other waste products, such as urea. The indigestible remainder which cannot be taken into the body is left in the intestines, somewhat as the clinkers are left in the ash pan.

Wastes from the Intestines.—Most of the material which is discharged from the intestines has never really been made a part of the living body. You remember that the alimentary canal runs from the mouth to the lower opening of the large intestine. As the food passes through the alimentary canal, the usable parts which the body needs are absorbed through the walls (mainly of the small intestine) into the blood stream, and the indigestible material remains finally in the large intestine, from which it must be discharged.

The Process of Excretion.—The real wastes of the body are the substances formed by the life processes in the cells.

These are carried away from the tissues in the blood stream, and must be removed from the blood or they would accumulate and poison the body. The removal of these wastes, such as carbon dioxide and urea, is brought about chiefly by the **organs of excretion**—the lungs, kidneys, liver, and skin.

In the lungs, the blood in the capillaries and the air in the air sacs are separated, as we have seen, by a thin membrane or layer of living cells. The carbon dioxide and some of the water vapor from the blood pass through this membrane into the air of the lungs and are discharged with the air which we exhale. The process of excretion is somewhat the same in kidneys, liver, and skin, except that in each of these organs the wastes pass from the blood into a special liquid, which is later discharged from the body. The wastes of the kidneys are discharged in the urine; the wastes of the liver, in the bile; and those of the skin, in the perspiration.

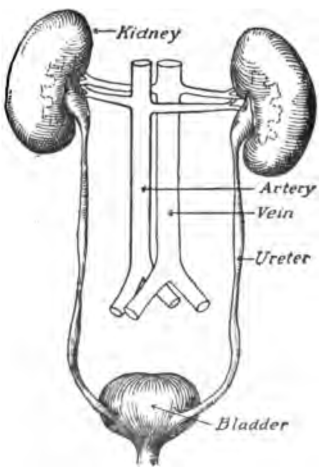

Fig. 59.—The kidneys and their connections.

The Kidneys.—The kidneys are two bean-shaped, dark red bodies which lie in the lower part of the back. Each kidney, in a grown person, measures about four inches by one and one half inches and weighs from four to six ounces. There are many blood vessels in the kidneys, and from the blood, the cells of the kidneys take out water and waste products, especially the wastes from

protein foods. The liquid thus filtered from the blood in the kidneys is called the urine.

The urine gathers in very small tubes in the kidneys and passes by two larger tubes into the urinary bladder, a muscular sac below the kidneys, where it is stored until discharged. The bladder holds about half a pint. Since some three pints of urine are formed every twenty-four hours, the bladder should be emptied about six times a day. An equal quantity of water is given off through the lungs and the skin, making a total daily excretion of about six pints.

In order to keep the kidneys working well, it is important to drink plenty of water and to eat freely of fruits, green vegetables, and other foods that contain water. The wastes of the body must be eliminated regularly, and the kidneys can do their work better if plenty of water passes through, along with the waste products.

The Liver as an Organ of Excretion.—Besides the indigestible waste material which it discharges, the digestive canal carries off a true bodily excretion, which it receives from the **bile,**—the fluid discharged by the liver.

The **liver** is the largest gland in the body, weighing three or four pounds. It lies in the upper part of the abdominal cavity just below the diaphragm. The bile which it forms may be discharged by the **bile duct** directly into the small intestine, or it may be stored for a time in a small sac called the **gall bladder,** connected with the bile duct. The bile has double work to do. It contains digestive juices which help in the digestion of fats, after the bile is discharged into the intestine. It also serves to get rid of some of the wastes of the body, which are excreted into it in the liver.

The Skin and the Perspiration.—The skin is not so necessary for getting rid of wastes as are the lungs, the kidneys,

and the liver, but it plays its own part in this important work.

Throughout the skin there are two or three million little pockets called **sweat glands,** which pour out perspiration. With a magnifying glass, you can see the tiny mouths of these glands as dark spots on the fine ridges of the skin. Usually the perspiration "dries up," or evaporates, as fast as it is poured out, but when one is hot or is doing hard muscular work, so much is formed that it gathers on the skin. The perspiration is, of course, mostly water, but it also contains waste products like those found in the urine.

The sweat glands, like the other organs of the body, are under the control of the nervous system, as is shown by the fact that a person who is frightened or embarrassed often "breaks out in a perspiration."

Effect of Alcohol on the Kidneys and the Liver.—Alcoholic drinks exert a very harmful effect upon the kidneys, often bringing on the serious trouble called Bright's disease. Old people may have Bright's disease because their kidneys have become worn out by long use, but alcohol often wears out the kidneys prematurely and brings on this trouble much earlier. The liver also may easily become diseased from the heavy burden of getting rid of too much alcohol or other poisonous material.

Questions for Discussion and Review

1. What would happen to a furnace if ashes were not removed, if clinkers were allowed to stay in the grate, and if the chimney were stopped up? Compare this to similar conditions in the body.

2. What difference is there between the wastes that pass off

through the large intestine and those that are carried away from the various organs by the blood stream?

3. What are the organs of excretion by which the wastes are removed from the blood?

4. In what special form does each organ of excretion throw off the wastes from the body?

5. Describe the process of excretion in the lungs.

6. Describe the kidneys. Where is the urine stored? How much is excreted daily?

7. How can we help the work of the kidneys by our diet?

8. Describe the liver. What double work does the bile perform?

9. What part does the skin play in the excretion of wastes?

10. In how many ways is water given off by the body? How is this loss made up?

11. Does the perspiration contain other substances besides water? If so, what becomes of them when the water evaporates?

CHAPTER XIII

HYGIENE OF THE SKIN

The Skin.—The skin covers the body, like a very tight suit of clothes. It has two layers, an outer layer of **scarf skin,** and an inner layer of **true skin.** When you have a blister on your hand, the outer scarf skin is puffed up by a liquid (the lymph) which collects between it and the true skin. The scarf skin, as you know from this experience, is very thin. The inner skin is thicker; leather is made from the inner skin of an animal, hardened by a special treatment called tanning.

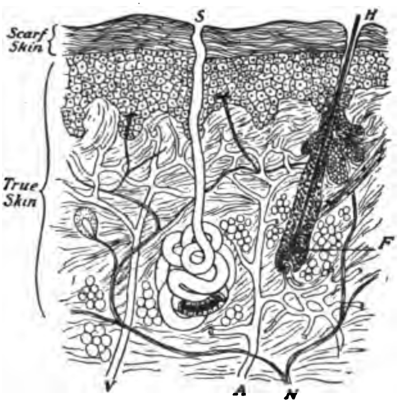

Fig. 60.—A section through the skin. A, artery; H, hair in hair follicle (F); N, nerve; S, sweat gland; V, vein.

The skin is growing all the time in its deeper layers and shedding off scales of dead tissue at the top. These scales are usually rubbed off in washing or by the friction of clothing, so that we do not notice them.

When the skin is subject to special pressure or friction at any one place, it grows thicker and forms a hardening, called **a callosity.** Rowers or baseball players often get callous places on their hands, and people who walk a great deal are

likely to have them on their feet. Corns are formed by such thickenings of the skin.

The Functions of the Skin.—The skin does several kinds of work. It keeps out disease germs and protects the soft, moist inside parts of the body from being injured and from losing water too fast by evaporation. It is by means of the blood vessels in the skin that the body gives off the heat which is constantly being produced inside; and by means of the sweat glands, the skin helps to get rid of the body wastes. The evaporation of the sweat which collects on the skin, as we have seen, cools the body and thus helps in the regulation of the body temperature.

Still another important work is accomplished by the little sense organs and nerves in the skin, by which we touch and feel, and learn a great deal about the world around us. It is through these organs of touch that we find out whether a thing is wet or dry, hot or cold, soft or hard.

Clothing and Shelter.—In cold weather the unclothed body would lose heat too fast, even if all the blood vessels of the skin contracted so as to become as small as possible. Birds have feathers and many animals have thick coats of hair to keep their heat in, but we must wear clothing to protect ourselves from cold. We must also have our houses specially warmed in cold weather. Next to food, clothing and shelter are the chief needs of the savage, and they demand a large proportion of the earnings of members of civilized society to-day. Men and women who support themselves and their families are called "bread-winners." They must be house-winners and clothes-winners as well.

Kinds of Clothing.—In choosing our clothing, we should remember that some materials are particularly effective in keeping heat in, while others allow it to escape more rapidly

to the outside air. Most of our clothing is made of animal hairs (woolen cloth and furs), of plant tissue (cotton or linen), or of silk, which is a fine web spun by a caterpillar. Woolen clothes are warm because they are very porous and hold a great deal of air; the air serves to retain the warmth

Fig. 61.—Very warm clothing is needed in the Arctic regions.

Fig. 62.—In warm countries, only light clothing is necessary.

or, as we sometimes say, it is a poor conductor of heat. Wool also takes up moisture readily, so that if it is moistened with perspiration it does not feel so wet and does not chill the body so much as other materials. Cotton is cooler and softer and is better fitted for warm-weather clothing.

It is well to remember that several layers of compara-

tively thin clothing are often warmer than one layer of thick clothing. The reason for this is that the air between the thicknesses of cloth helps to keep the heat of the body from escaping. A newspaper folded under the clothing will prove a considerable protection against sudden cold, because of the layers of air between its folds.

Hygiene of the Clothing.—It is important to regulate the amount of the clothing with some care. If clothes are so thin that the body becomes chilled, colds and rheumatism and other diseases may result. We should be careful to be warmly wrapped while sitting still or lying down in the cold air. When we are active and are using the muscles a great deal, more heat is formed in the body and less clothing is needed—while the exercise is going on. People often, however, become heated by exercise and afterward sit down or stand in cold drafts. This is one of the easiest methods of getting a cold. After exercise, the blood vessels in the skin are expanded, the body is wet with perspiration, and heat is being rapidly drawn off by its evaporation. If the body in this condition is exposed to a cold draft of air, it becomes cool too rapidly and a chill is likely to result. Even at the risk of being a little too warm for a few minutes, one should put on an extra wrap until the body has regained its normal temperature.

Wet clothes and shoes are likely to cause chills, because water conducts heat away from the body very rapidly. We should be careful, therefore, to change damp clothing for dry things as soon as possible.

On the other hand, it is just as undesirable to wear clothes that are too warm as to expose the body to undue chill. As we have seen in the chapter on "Air and Health," if the

skin cannot get rid of its heat fast enough, we feel dull and sleepy. People who have the habit of wearing too many clothes weaken the power of their systems to respond quickly to changes in temperature, and so are especially susceptible to colds. The way to keep the skin and its blood vessels in good condition is to wear light clothing indoors and to put on outer wraps when one goes out into the cold.

Hygiene of Bathing.—The first object of bathing is, of course, to keep clean. Not only should the dirt and soot which soil the body be washed off, but the waste materials deposited on the skin by perspiration must also be removed. If a daily bath is not taken, the body and the clothing soon acquire an unpleasant odor.

Warm or tepid water is most effective for cleansing the hands or body. Bathing in warm water increases the size of the blood vessels in the skin and draws the blood away from the brain, making one feel comfortably sleepy. This is the reason why a warm bath should usually be taken at bedtime.

A cold bath contracts the skin blood vessels and drives the blood to the internal organs and the brain, making one feel alert and keen. Cold bathing is a powerful tonic to the skin, since it trains these blood vessels to respond quickly to changes in temperature. People who take cold baths regularly are likely to be hardy and little subject to colds.

In the matter of bathing, however, we must again remember that the body should be stimulated by cold but not chilled too much. A cold bath should be followed by a **reaction**; that is, the surface blood vessels should enlarge again so that the skin becomes warm and glowing. Brisk

rubbing with a rough towel helps to secure this reaction. If no reaction follows, or if one feels tired after bathing, the bath was too cold or too prolonged, or the body is not strong enough to endure the shock. In such cases, cold baths may do serious harm.

No bath of any kind should be taken within an hour after eating. The blood is needed in the intestines for the process of digestion, and it is harmful to disturb the circulation, as any bath must do, at such a time.

The Care of the Hair.—The hair is a kind of outgrowth of the skin, as are the feathers of birds and the scales of fishes. Each hair grows out of a tiny cup called a **hair follicle.** Opening into the hair follicle are glands which discharge an oily secretion that keeps the hair soft and flexible. (See Fig. 60.)

Vigorous brushing of the hair is necessary, not only to keep the hair free from snarls and neat in appearance, but also to keep the scalp healthy, by bringing the blood into it and working the natural oil out to the ends of the hairs. Washing the hair with warm water and good soap at least once a month is desirable, in order that the scalp may be kept clean of scales and dirt. After washing, the hair should be thoroughly rinsed to remove all the soap.

Microbes on the Skin.—Germs of various kinds are always present on the skin. These germs ordinarily do no harm, but when a person is "run down," tired, and in poor condition, they may grow in a hair follicle and cause a little swelling or pimple. Boils or carbuncles are more extensive germ infections of this kind. Children may occasionally have pimples and even a boil without any serious cause, but if the pimples appear frequently a physician should be consulted.

The Care of the Nails.—The nails are folds of the skin that have become hard and horny at the ends, but are alive and growing at the base. Finger nails are great dirt catchers, and special care is required to keep them clean. Black-bordered finger nails are an unpleasant sight, and there is always a possibility that dirty nails (which are germ-bearing nails) may introduce dangerous microbes into the skin by scratching or rubbing, or may carry pollution to one's food. The nails should be kept fairly short so that they are not in danger of being broken. They should never be bitten or picked, as the result is always unsightly and these practices often lead to the tearing of the delicate flesh below the nail. Germs are likely to get into any such wounded place and may cause serious infections.

Questions for Discussion and Review

1. What are the functions of the skin?

2. How does the skin grow? What color is it? What gives it this color?

3. How does the body get rid of the heat produced by the activities of its different organs?

4. How do we prevent the body from losing heat too rapidly?

5. What are the three chief physical needs of mankind? Why?

6. What kinds of material can you name which are used for clothing? From what is each made?

7. Why is fur clothing warm? Is it warmer, worn with the fur side in or out? Why?

8. Up-to-date manufacturers are making underwear of thick loosely-woven cotton. How does this compare with woolen underwear?

9. Take pieces of wool, silk, and cotton, soak each thor-

oughly, and then see which will dry most quickly. What does this show you about the choice of material for clothing?

10. In bed clothing, which is better, one heavy blanket or two lighter ones?

11. Why do double doors and windows help to keep a house warm?

12. What is the danger when people try to "harden" themselves quickly by wearing too little clothing?

13. Some boys were taking a long walk, and when they were five miles from home a heavy rain came up. Of course their feet became very wet. One of the boys feared that they would all take cold, but another said that it was all right provided they kept walking and changed their clothes as soon as they reached home. Which was right? Explain.

14. Why is it unsafe to come to school in the rain without rubbers or a change of shoes?

15. Is it safer to dress too heavily than to dress too lightly?

16. Why should material which is unwashable never be worn next to the skin?

17. For cleanliness, which is better, a warm or a cold bath? Which is better for "toning" the body? How can you get both effects?

18. What kind of bath is good at bedtime? What kind after hard exercise? Why?

19. In swimming, we often find that the water feels icy cold at the first plunge. Why does it seem warmer after we have been swimming for a while? If the swimmer does not succeed in warming up, what is probably the matter?

20. How are the skin and the hair kept soft and flexible?

21. Why does brushing the hair help to make it glossy?

22. What are pimples?

23. How should the nails be cared for?

CHAPTER XIV

THE NERVOUS SYSTEM

The Function of the Nervous System.—The human body is a delicate and complicated machine, every part of which must act in harmony with every other part, if the whole machine is to do its work properly. The heart must beat just so fast and the walls of the blood vessels must exert just so much pressure upon the blood. The lungs must be expanded so as to inhale the air just so often. The intestines must move the food along, and the glands must pour out the different digestive juices, each in the right amount. The kidneys must get rid of the wastes, and a score of other processes must proceed in constant harmony. If any part of the body works too fast or too slowly, the balance of the machine is upset and disease results; for *disease is failure of the living machine to do its work properly.*

This, however, is only a part of the story. It would not do for the body to work at the same rate all the time, like an ordinary lifeless machine. It has to change its behavior to meet different conditions. Suppose you have been sitting still and then get up and play a game of tag or baseball. Your muscles begin to work, and at once your whole body must adapt itself to the new activity. The heart must beat faster to send to the muscles the blood they need for their extra activity. The breathing must be deepened and quickened to supply more oxygen. The blood vessels in the skin must be made larger, and the sweat glands must begin to work so as to get rid of the waste products. In order that all

these changes shall be properly made, there must be something to control and direct all the parts of the body. This power which governs the body and makes its teamwork possible is the **nervous system.**

The Central Nervous System.—The brain, the spinal cord, and the nerves that run out from them are the chief organs which carry out this important work. They constitute what is called the **central nervous system.**

How the Nervous System Works.—You have perhaps seen a switchboard in a telephone exchange. From this switchboard, hundreds of wires run out to buildings in every part of the town. "493 Broad" calls up and wishes to talk to "287 Main"; and the operator makes the connection, so that the people in these two houses can speak to each other. The nervous system of the body works in somewhat the same way. The brain and the spinal cord are like the switchboard; from them nerves run to all parts of the body, like tiny telephone wires, bringing in messages as to what is happening and sending out messages to control and direct action.

We do not know just how messages are carried along the nerves, but we do know that each nerve serves a certain part of the body and carries a certain kind of message. A prick on the finger hurts because special sense organs in the skin are connected with nerves which cause sensations of *pain*. The nerves from the eyes cause sensations of ***light;*** if these nerves were cut or injured behind the eye, there would be no pain but a sensation like a flash of light. In the same way, the nerves which control the contraction of muscles cause definite movements in particular parts of the body. For instance, in a frog there is a certain nerve which, if pinched, makes the leg kick, even after the frog is killed and dissected.

Special parts of the brain and cord govern the actions of special parts of the body. A blow on a certain part of the head may, for instance, cause paralysis of the legs, so that the person injured in this way becomes a cripple and cannot

Fig. 63.—The central nervous system is somewhat like a telephone switchboard, where messages come from and go to all parts of the body.

walk, while an injury to another part of the head may take away the power of speech.

The Nerves.—The nerves are shining white threads running out from the brain or the spinal cord. These nerve

trunks subdivide again and again, and branch out, like the branches of a tree, till they reach every part of the body. The largest of the main nerve trunks, which runs down the leg, is the size of a large lead pencil.

The nerve trunks are bundles of fine threads or **nerve fibers,** which are of two kinds: **sensory** fibers which bring *in* sensations from the various parts of the body to the brain

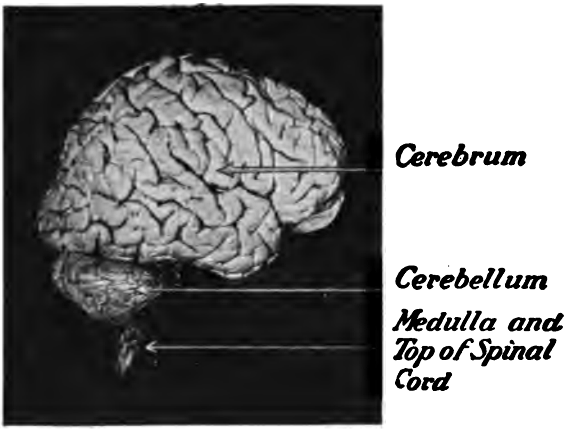

Fig. 64.—The human brain.

and cord, and **motor** fibers which carry *out* the messages causing action of the muscles or other organs.

If you could trace one of the tiny nerve fibers (perhaps one-thousandth of an inch in diameter) in a main nerve trunk, you would find in most cases that it ran continuously, like an independent little telephone wire, right into a special **nerve cell** in the brain (or spinal cord). These nerve cells are situated in swellings of the nerve trunks called **ganglia.** The nerve fiber that controls the muscles of the foot can be followed to the lower part of the spinal cord in the back, for a distance of over three feet.

The Brain.—The brain is a large organ, weighing nearly three pounds, which almost fills the inside of the skull. It is shaped somewhat like an oval loaf of bread, with a deep groove along its upper side, and has a very irregular surface with many smaller grooves and wrinkles in it. In man, these grooves and wrinkles are much more fully developed than in the lower animals. It is interesting to note, also, that the size of the brain varies greatly in different animals, being usually much larger in the more intelligent species.

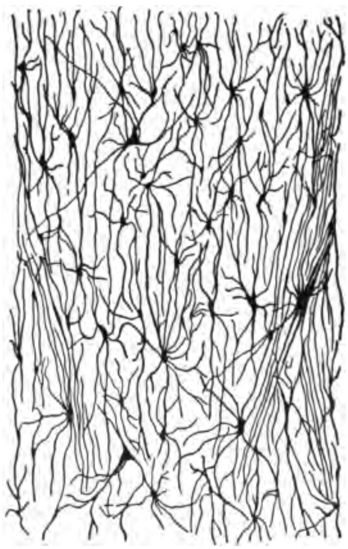

Fig. 65.—Network of cells in the gray matter of the brain.

The brain is largely made up of the complicated network of white nerve fibers which run into it. Large bundles of these fibers enter the brain from the eyes and from the nose and ears, while at the bottom of the skull there is an opening for the great number of nerves which enter from the spinal cord.

The Gray Matter.—The most interesting thing in the brain is the **gray matter,** which makes up its outer layers. This gray matter contains the nerve cells into which the nerve fibers run. These cells exert certain chemical or physical effects on one another; and it is by these effects that the messages entering along the sensory fibers cause sensations, and lead to the

sending out of messages of action along the motor fibers.

The Three Parts of the Brain.—There are three principal regions of the brain (see Fig. 64). The largest part, which lies over and covers up the others, is the forebrain or **cerebrum.** It is through the activity of this part of the brain that we are *conscious* of sensations such as we obtain by seeing, hearing, smelling, and tasting. The cerebrum is the seat also of all reasoning and thinking processes, and by the messages it sends out controls our voluntary actions.

The hind-brain is called the **cerebellum**, and below it lies the **medulla** (mē̇ dŭl′ ȧ). They control such actions as those involved in walking and breathing, which are called involuntary actions because they usually occur without any willing on our part.

The Spinal Cord.—The outside of the spinal cord is covered with a white sheath of nerve fibers, and the center is made up of gray matter like that on the outside of the brain. As the cord passes through the arches of the vertebral column, it gives off a pair of nerves at each vertebra, one to each side of the body. Each of the sixty-two spinal nerves, which run out in this way from the thirty-one vertebræ, subdivides again and again till the hundreds of fine thread-like branches finally reach all parts of the body.

The Sympathetic System.—Besides the brain and cord and the nerves directly connected with them, which make up the central nervous system, there is another important group of ganglia and nerve fibers which form the **sympathetic system.** Some of these ganglia lie in two chains, one on each side of the spinal column, and others are scattered through the various organs of the body. They are con-

nected with one another and with the spinal cord by a complex network of nerve fibers.

These ganglia control, in particular, the automatic internal organs, such as the heart, blood vessels, and digestive organs, as well as the heat-regulating and sweat-regulating machinery of the skin. It is because they keep the internal organs working together, as if they were "in sympathy" with one another, that they were given the name "sympathetic system." It should be remembered, however, that the sympathetic ganglia do not make up a wholly distinct system. They are connected by special fibers with the spinal cord. They send sensory messages to it and get motor messages from it.

Reflex Actions.—Among our commonest activities are the **reflex actions**—actions that are caused directly by some sensory message carried to the central nervous system and there changed into a motor impulse without the action of the will. The particular work of the spinal cord and the lower parts of the brain is to serve as a kind of switchboard for the control of these reflex actions.

A reflex action may perhaps be best understood by an illustration. Suppose you put your finger on the hot stove. You draw it away as quick as a flash. You do not have to think about it; in fact, you would find it hard to keep your finger on the stove if you tried to do so.

In that short moment between the time your finger touched the stove and the time it was drawn away, a good deal happened. First the heat took effect in the skin. Then a message passed up the sensory fibers to the spinal cord to report that something was wrong at the tip of that finger. In the cord, the connection was made between this incoming nerve from the finger and the motor fibers going out to the

muscles of the arm; and out along these nerves went the message which caused the arm to contract and draw away.

Reflex actions are very common. Dust tickles your throat and you cough. A cinder gets into your eyes and the tears flow. You stumble and your hands go out to save yourself from falling. All these are reflexes. In each case, a message comes into the nervous system recording some condition outside. It passes to the brain or spinal cord along the sensory nerves; there, connection is made with another set of nerves; and out along these nerves goes an impulse that causes the necessary action.

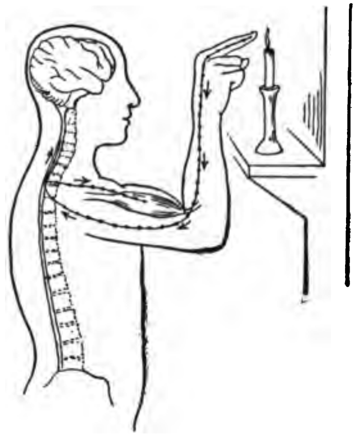

Fig. 66.—Diagram illustrating the mechanism of a reflex action.

It may seem to you that you pull your arm away from the hot stove voluntarily, because the nerve message, after making the connection in the cord, passes on to the brain and you are conscious of what you have done. But, in reality, the message to pull away your arm had gone out from the cord before your brain knew that your finger had been burned.

Actions that Become Reflex by Habit.—Many of the reflex actions of the body, such as winking when something comes near the eye, or coughing when something tickles the throat, are natural and do not have to be learned. Other actions, which at first require the direction of the brain, later become reflex by repetition. For example, when a

child first learns to ride a bicycle, he must think of each movement (using his cerebrum). Even with all his care, his legs do not work together properly, and he loses his balance and runs into the trees along the road. Gradually, however, practice makes him more expert. He learns to keep his balance by swaying to the right if his bicycle leans to the left. After a time the process becomes quite automatic, so that he leaps on his wheel and rides off without thinking of it at all. If there is something in the way, a message goes in from his eyes to his brain, down the cord, and out to the muscles, and he turns aside and passes the obstacle smoothly and unconsciously.

What has happened in such a case as this? A new set of reflexes has been created, which the body did not have before. A new set of connections has been formed between various sensory and motor nerve fibers in the cord or lower part of the brain, so that the first hint of a loss of balance starts certain muscles contracting in just the right way to keep the body upright on the wheel.

Inhibitions.—An enormous number of reflex actions are possible in the body. Some of them produce opposite effects; that is, one reflex action may change or stop the action of another reflex. A sneeze is an example of an ordinary reflex action. Often, however, when you feel that you are going to sneeze, you can stop it by pressing your finger hard on your upper lip. This pressure on the lip produces a nerve impulse that inhibits, or stops, the sneeze reflex. A nerve message which tends to stop the action of another reflex is called an **inhibitory impulse.**

Involuntary Actions.—Many actions of the body are quite outside the control of the will. We cannot stop the heart from beating or make saliva flow by willing to do so.

The motor fibers which cause these actions are set in activity either by a reflex impulse from a sensory fiber, or perhaps by a more direct effect of some chemical or physical change in the tissues (producing what are called **automatic** actions).

It is probable that the actions of such creatures as insects are of this reflex and automatic kind, even the very complicated reflexes that are called **instincts.** It is instinct, for example, which teaches the butterfly to lay its eggs on the particular kind of plant that furnishes food for the caterpillar that is to hatch from the eggs.

Voluntary Actions.—In some of our actions the will plays a definite part, although the line between voluntary and involuntary actions cannot always be sharply drawn. Certain activities may sometimes be unconscious reflexes and sometimes voluntary acts. The eye winks without our thinking about it, when something comes near it, but we can perform the same act by willing to do so. Inhibitions play a large part in voluntary actions. If something hot is put into the palm of your hand, there is a natural reflex impulse to drop it; but if it is not *too* hot, you can control the impulse and hold the object by making up your mind to do so.

The voluntary acts (done because we definitely will to do them) are all controlled by the forebrain, or cerebrum. The power of speech and of writing, and our more complicated actions, as well as consciousness—the knowledge of ourselves and our feelings and of the world about us—are all dependent upon the cerebrum and are lost if this part of the brain is injured. The simpler reflexes—such as the movements of balance or the tendency to draw back a part of the body when it is hurt—can be carried on by the lower part of the

brain and the cord even when the cerebrum has been destroyed.

Habits and Their Importance.—The example of learning to ride a bicycle illustrates the importance of *habit* in daily life. Every time a certain act is performed, it becomes easier to do that thing again. The gray matter in the brain makes any nerve connection more readily the second time. It would probably be hard for you to keep tossing up and catching one ball a great many times without missing it. The jugglers in a circus, however, can keep half a dozen balls in the air without dropping one, simply because they have practiced until they have trained their reflexes so that eye and hand work perfectly together.

Fig. 67.—The success of the juggler comes from the patient training of muscle and of nerve until the skill of eye and hand becomes a habit.

It is not only in juggling balls, and in other physical actions, that the forming of habits is important. There are mental habits, too. The training of a soldier consists not only in teaching him how to use his gun, but also in teaching him to be brave and obedient and to do what he is told by

his officer without a second's delay. The qualities of courage and obedience, which are needed among soldiers, are just as necessary in everyday life. People do not live in a world by themselves, like Robinson Crusoe. We must all work together, and if we are to be useful and lovable and are to get on in the world, we must learn to do quickly what we are

Fig. 68.—Keeping step. It is only by the formation of good habits that men are able to march together or to work together with success.

told by those in authority. Obedience is a habit which can be learned only by obeying. Cheerfulness and politeness are habits which become easier every time we practice them. Courage is a habit. Each time we master a difficult lesson, or perform an unpleasant task for the sake of some one else, we have blazed a trail that will make the way smoother next time.

Unfortunately the same thing holds true of bad habits.

Some people unconsciously allow themselves to form habits of disobedience, surliness, and cowardice which become so fixed that they can scarcely be overcome.

It may help us to realize the importance of doing the right thing, if we remember that every act and choice of ours really makes a kind of mark upon our nervous system which influences our future acts and choices. The time to form habits is in youth, when the nervous system and its reflexes are most easily influenced. You can bend a young sapling or even tie it in a knot; but when it has grown into a tree, nothing can change its form, except breaking it to bits. It is somewhat so with ourselves. A child can form habits easily, but a man who did not form good habits in youth has hard work to change afterward.

Hygiene of the Nervous System.—The nervous system, like the other parts of the body, needs rest to keep it healthy; and since the nerve cells of the cerebrum are working very hard all the time we are awake, their need for rest is particularly great. Fatigue after great physical or mental labor is caused by the fact that the muscles or the nerves have been worked so hard that waste products have collected too fast to be carried off by the blood and lymph, and are poisoning the tissues which produced them. Fatigue is nature's danger signal and should always be heeded. In the hurry and pressure of modern life, many people forget this and drive their bodies so hard that they break down and have nervous prostration or some other mental disease.

It is not *hard* work that causes these breakdowns so much as *long-continued* work and *worry*. A healthy body and brain will stand hard work. If a man tries to hold a heavy weight in the air too long, however, he may strain himself seriously; and it is much the same with the mind.

Long concentrated work of one kind is particularly harmful. If people were wiser, they would realize that they can accomplish more and keep in better health by working for shorter periods and resting between. Some kinds of amusements, like social gayeties, may be carried so far as to be more tiring than work itself; and many girls and women break down from working too hard at this kind of play.

When we do work, however, it is well to work seriously. Children, and grown people too, waste an enormous amount of time by *half-working*, letting their minds wander while they gaze out of the window. The habit of concentrating the mind can be steadily strengthened by practice, and it is one of the finest habits that any boy or girl can form.

Worry and crossness are very wearing, and one fit of anger harms the nervous system more than hours of hard work. It is important to form the habit of even-tempered cheerfulness, and this is possible for every one in a considerable degree. A cheerful person can do far more work and feel less tired than a cross and worrying one.

Rest and Play.—There are many ways of resting the brain and nerves; and people differ greatly in their rest needs. Some are rested by a change of work. In general, any occupation which calls for varied kinds of mental activity is much less of a strain than doing the same thing all the time. Many people get their rest or recreation (a very good word, since it means re-creation or building up again) by turning to some hobby, such as gardening, or studying birds, or collecting stamps or insects. These hobbies keep the mind active and interested, but call for the use of different brain cells from those which are used in daily work. The habit of reading is a great help to many people, who always turn to a book for relaxation. Others

who do much brain work like to rest the nervous system by vigorous physical exercise, such as tennis, or by long walks in the open air; and some people's ideal of rest is to lie in a hammock or under an apple tree.

The Importance of Sleep.—The only complete rest for both body and mind is in sleep, and no one can keep healthy without satisfying this need. In sleep, the blood supply going to the brain is so decreased that we lose consciousness; that is, we do not think or feel or have any knowledge of what is going on about us. The depth or completeness of sleep varies. During the first part of the night one usually sleeps soundly, while toward morning it becomes more and more easy to wake up to full consciousness. Halfway between sleep and waking is the land of dreams in which, as the blood goes back into the brain and the nerve cells begin to act again, strange memories and associations of all kinds form a curious, confused picture in the mind. In a state of deep and dreamless sleep, the cells of the nervous system are best able to free themselves of their waste products and build themselves up again for the work of the coming day.

Individuals vary in the amount of sleep they require, although most grown people need about eight hours. Children who are growing fast and leading an active life need more, ten hours at least, and babies sleep from fifteen to twenty hours out of the twenty-four. It never pays to reduce the hours needed for sleep, except now and then for some special emergency.

When one has been working very hard, or is "run down" by illness, or for any other reason needs special care, it is a great help to take a nap in the middle of the day, or even to lie down and rest a half hour without actually going to

sleep. A little rest which breaks the day's work is more useful than a much longer time added to the night's sleep.

Questions for Discussion and Review

1. How does the nervous system enable the various organs to work together?

2. Give examples of how the work of the skin, the lungs, and the intestines is varied to meet different outside conditions.

3. What do we mean by the central nervous system? The sympathetic system? What is the work of each?

4. What are nerve fibers? Nerve cells? Where are each located?

5. What is the difference between a sensory nerve fiber and a motor nerve fiber? Compare with telephone wires.

6. Which are better protected, the brain and spinal cord, or the nerve fibers?

7. How does the size of a man's brain compare with that of other animals? Is a man's brain smoother or does it have more ridges than the brains of other animals?

8. What is the gray matter in the central nervous system? Where is it located?

9. Describe the brain and tell the special work of the different parts.

10. What is a reflex action? Give examples.

11. What is the use of reflex actions?

12. Some reflexes do not have to be learned (we say they are "instinctive"); others have to be acquired by practice. Give examples of each kind of reflex.

13. Under what control are the feet when we are learning to skate? After we have learned?

14. Why is it that after learning to play the piano you do not have to stop to think what notes to strike?

15. Are all reflexes useful? Name some that are harmful. How may they be controlled?

16. What do we mean by inhibitions? Give examples of inhibitions which would make you a better citizen.

17. How do inhibitions play a part in learning to be brave? In learning a fire drill?

18. Can the process of digestion be controlled by the will? Can perspiration be controlled? Breathing?

19. Can habits of courage be acquired? Is telling the truth a habit?

20. Why is it important not to allow yourself to say "ain't" or "haven't got," even in fun?

21. Apply to some definite case these rules for habit formation:

1. When you have decided what to do, do it at the first opportunity that arises.
2. Repeat it as often as possible.
3. Do not let a single exception occur.

22. What is fatigue? Does it occur in muscles? In nerves?

23. Cheerfulness makes a smoothly running machine. Crossness and worry take the oil out of the joints and bearings. Under which of these conditions does the machine do better work?

24. How do nerves rest?

25. "All work and no play makes Jack a dull boy." Why is play beneficial?

26. Why is sleep necessary? Make a set of rules for sleep, including number of hours, air, bed, and bedding.

27. What is the use of a nap in the middle of the day?

CHAPTER XV

ALCOHOL AND HABIT-FORMING DRUGS AND THEIR EFFECTS UPON EFFICIENCY

Effects of Drugs.—The difference between foods and drugs has been pointed out, and the effects of certain drugs, particularly alcohol, upon the physical health of the body have been discussed at various places in this book. We have seen that alcohol and other poisons may gravely injure the digestive system, heart, blood vessels, kidneys, and liver. Their most serious effects, however, are exerted upon the nervous system and are closely related to the general efficiency of the body as a nervous mechanism. This problem is so important as to deserve discussion in a separate chapter.

Alcohol not a Stimulant.—It was once believed that alcohol was a useful stimulant, and that alcoholic drinks could be used to whip up the bodily machine to make special efforts in some great emergency. It was pointed out in Chapter VIII that alcohol is not really a useful stimulant so far as physical exertion is concerned, and after our study of the nervous system we can understand better just what the action of alcohol really is.

Alcohol, like many other drugs, acts chiefly on the nervous system; it does not serve to make any part of the nervous system work more readily, but numbs or puts to sleep certain parts of it. It acts first of all on the inhibitions, with the result that some of the nerve actions which would ordinarily be inhibited or held in check are allowed

to go on more freely. This seems like a stimulation or increase of power, but it is really only a breakdown of the system of control. The situation is somewhat similar to the case of a runaway horse. The horse is no stronger, but is much more dangerous, when it is running away than when it is held firmly by the reins in the hands of a skilled driver.

A person slightly under the influence of alcohol may, for instance, talk more and speak more loudly than normally, simply because his thoughtfulness and self-respect and courtesy have been forgotten. Still larger doses of alcohol carry the numbing effect further. The brain becomes more and more clouded, the speech thick, the gait unsteady, and finally a heavy and unnatural sleep may result, followed by headache and acute discomfort on awaking.

At all stages the alcohol is acting, in lesser or greater degree, not as a stimulant but as a **narcotic**—that is, a drug that puts the nervous system or some part of it to sleep, and numbs the faculties and powers of the body.

The Changing Viewpoint about Alcohol.—These facts were not fully understood until recent years. In former times, people used wine and beer and strong drinks much more freely than they do to-day, for no one realized how much harm was done by them. In some of the older books you read, you may find the use of alcoholic drinks treated as if it were a rather fine thing. No one who has studied the matter to-day, however, doubts that alcohol is a grave danger and a damage to mankind.

While the writer was first preparing this chapter (before prohibition became a law), two things came to his notice which illustrated this changing point of view. In a book by a great physician, he read a passage describing a shooting competition fifty years ago, when the physician and the

other men who were shooting for prizes drank champagne freely during the match, with no idea that it would harm their accuracy. The day after reading this passage, the writer heard a friend describe his work in getting up rifle clubs in which men are learning to defend their country if the need should come. The friend said, "We find these rifle clubs are great things for the men. It keeps them out of the saloon, for of course they all know that they cannot shoot straight if they drink."

Laboratory Studies of the Effect of Alcohol on Efficiency. Many physiologists, who have carefully studied the effect of alcohol upon various activities of the body, have found that the use of alcoholic drinks interferes in a marked degree with work that requires accuracy and quickness. The power of learning by heart or memorizing, accuracy in adding columns of figures, and speed and accuracy in setting type in printing offices have all been studied in this way, with similar results.

The most thorough and careful work of this kind is that which has been carried out by Professor F. G. Benedict and his associates in the Carnegie Nutrition Laboratory at Boston. The way these studies were made can be understood by considering one of the many tests that were applied, first to young men who took no alcohol, and then, on another day, to the same young men before and after taking a dose of the drug.

In the particular test in question, words of four letters were printed on a surface which moved along behind a screen. In this screen there was a slit through which each word could be seen as it passed. By an electrical apparatus, the exact time at which the word appeared was recorded to a fraction of a second. When the man who was being ex-

perimented with saw the word, he pronounced it as quickly as possible, and the time at which the sound of his voice was heard was accurately recorded by an electrical instrument connected with a kind of telephone receiver. The difference between the time when the word appeared and

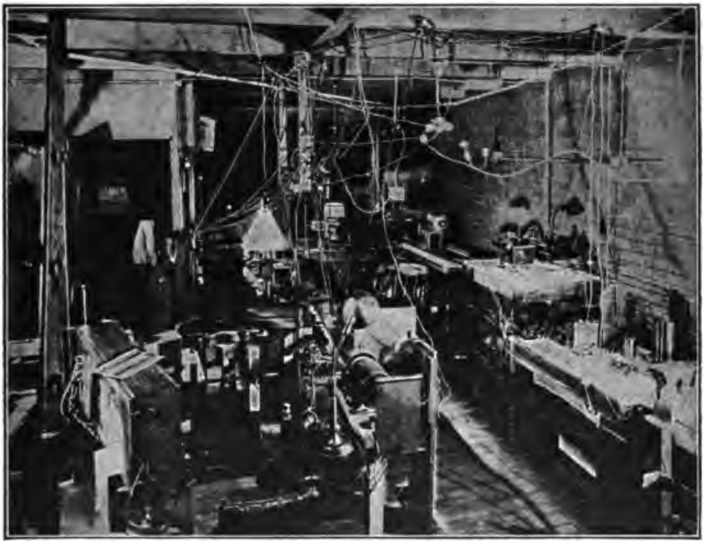

Fig. 69.—Laboratory of the Carnegie Institution, showing the elaborate apparatus used in testing the effect of alcohol on efficiency.

the time when it was pronounced was a measure of the quickness of action of his nerves and brain and speech muscles.

This was only one of the many reactions of the body which were studied by Dr. Benedict. He measured the rate of closing the eyelid in response to a movement in front of it; the quickness with which the eye could be turned to look from one thing to another; the quickness of finger

movements; the sensitiveness of the skin to slight electric currents; and the power to memorize words. The tests of memory and another of the more complicated tests showed but slight effects from the amount of alcohol used in these experiments; all the other tests (nine in all), however, showed a decrease in quickness or accuracy of from 3 to 46 per cent in the persons who had taken alcohol. This indicates very clearly that this drug tends seriously to interfere with the working of the nervous machinery of the body and to make its reactions slow and clumsy.

Relation of Alcoholic Indulgence to Accidents.—The fact that alcoholic drinks interfere in this way with the quick and accurate working of the living machine makes alcohol very often a factor in more or less serious accidents. A great number of automobile accidents are due to the driver's being under the influence of liquor, and the same connection is observed in industrial life. European statistics of sickness insurance societies (which make weekly payment to their members when disabled) show a larger number of accidents on Monday than on any other day of the week. This is generally explained as being the result of intemperance during the holiday, although it is probably in part due to other causes. An American ironworks reported that there was a decrease of 54 per cent in the number of accidents in the plant during the first six months after the saloons in the town were closed.

There are laws in many states which provide for Workmen's Compensation, or the payment of a sum of money to men injured while at work, and almost all of them provide that no payment shall be made in the case of accidents due to intoxication—showing how generally alcohol is recognized as a cause of industrial accidents.

Alcohol and Industry.—Some years ago it came to be clearly recognized that alcohol and efficiency in business and industry do not go together.

The Commissioner of Labor of the United States in his Twelfth Annual Report (1897–1898) on *Economic Aspects of the Liquor Problem* reported the attitude of employers at that time, as indicated by replies to a circular letter from establishments employing a million and three quarters of workers. Of 6976 employers, 5363 reported that in employing new men they considered the applicant's use of liquor as an important factor. In some establishments, no one known to use intoxicating liquors was employed, while in others the rule applied only to especially responsible or dangerous kinds of work. The use of alcohol was prohibited on or off duty for all employees in 696 establishments, and for certain groups of employees in 1283. The use of alcohol while on duty was forbidden for all employees in 855 establishments and for certain groups of employees in 692 more.

A later study of this question, presented by Dr. Alexander Fleisher at the National Conference of Charities and Corrections at Indianapolis, May 14, 1916, shows that there had been rapid and general progress along the same lines. Of ten railroads, employing 400,000 employees, all reported rules in regard to the use of alcohol, of which the following is an example, although some of the rules were not quite so stringent: "The use of intoxicants by employees subject to call is prohibited. Their use by any employee or the frequenting of places where they are sold is sufficient cause for dismissal."

One railroad official wrote in regard to this question, "The policy of the company, as expressed by its chief officers

in their personal lives and influence, is to eliminate entirely the use of intoxicants, whether on or off duty. With that idea in view, the sale of intoxicants has been taken off dining cars and out of all eating houses where the company is in absolute control. This has been done so as to show the employees an actual example of the desire of the company to remove intoxicants from its premises, and to let those who wish to use them obtain them off the lines of the road rather than on railroad property."

Much the same feeling is shown in the replies received by Dr. Fleisher from street railroads, telephone and gas companies, department stores, mining companies, steel companies, and various manufacturing plants. In these industries, rules against the use of alcohol were not so severe as in railroading, where a moment's slip may mean great danger to hundreds of people. In almost all of them, however, the danger of alcohol was clearly recognized, and everything possible was done to encourage and advance the man who did not drink.

One street railway company employing 8000 men, for instance, had a strict rule against the use of intoxicating liquors and the visiting of saloons. Every applicant for a job was questioned under oath, and if he used intoxicating liquor he was not employed. Of four steel companies, one prohibited the use of alcohol by employees at any time and the other three issued notices to the workmen stating that they hoped the men would not use intoxicating liquors, that any one using such liquors while on duty would be discharged, and that the man who did not drink would always be given first chance of promotion.

Dr. Fleisher sums up the results of his study as follows: "We have returns from the employers of 750,000 in-

dividuals; this is four per cent of those engaged in trade, transportation, and the mechanical and manufacturing industries of the United States. These employers forbid alcohol in their plants; in many instances its use is considered in the promotion and retention of employees; its use at any time is prohibited in such industries as transportation, and this practice is being followed by some industrial establishments.

"This analysis indicates that a number of employers are making up their minds on the use of alcohol by their employees. By whatever reasoning they are arriving at their conclusion—whether they feel it is in the interest of the public, of the employee, or of good business—they seem to be taking a stand against the man who uses alcohol. They are not considering the intricate questions of the effects of alcohol on the mind and body—these preliminaries have been ignored; they find the non-drinker the more satisfactory employee."

Relation of Alcohol to Nervous Diseases.—So far in this chapter we have been dealing, for the most part, with the effects of even moderate doses of alcohol in lowering efficiency. It must always be remembered, however, that the harm done to habitual drinkers is very much more serious, and a word should be said as to the dangers of a coutinued use of this poison.

Many unfortunate individuals, without knowing it, come to use more and more alcohol as time goes on. The nervous system gradually comes to crave the effect and requires larger and larger doses to satisfy this craving. Each day the habit seems harder to break off. The moral strength, the will, may be undermined in such a case till the victim becomes a helpless slave to his habit.

The poisonous effects of large and continued doses of alcohol are, of course, very serious. In addition to the injury to the heart and blood vessels, the kidneys and the liver, it is likely that the nervous system may break down. The state of physical, mental, and moral weakness which follows is one of the most pitiable conditions into which a person can fall.

A recent report of a New Zealand State Board of Insanity estimated that about 10 per cent of a group of insane persons owed their condition to the excessive use of alcohol. Other authorities place the proportion much higher.

The Cost of Alcohol.—The price which society has paid for the use of alcohol is a heavy one.

Dr. A. B. Armstrong of the New York Association for Improving the Condition of the Poor has outlined some of the factors in this burden laid on us by alcohol, as follows:

1. *The Annual Cost:* The annual cost of the production and importation of alcoholic beverages in the United States was about $610,000,000. What would this mean in accomplishment if the same funds could be devoted to constructive education, to scientific research, or to disease prevention?

2. *The Waste from Disease:* Besides the not easily measured incapacity and inefficiency resulting from long continued, even moderate, drinking, we have had the unnecessary diseases and death from physical and mental causes, involving a tremendous waste in human productivity and human life.

3. *The Industrial Waste:* The application of sobriety to industry means efficiency, productivity, a decrease in accidents and sickness, and a decrease in wages lost, and in medical cost. Railroad companies and other industrial concerns long ago realized the necessity for restriction in

this field and have attempted to control the habits of their workers, even during the hours when they are not actually employed.

4. *The Economic Wastage* Resulting from Poverty, Destitution, and Crime. Under this heading, Dr. Armstrong reviews the conflicting evidence and concludes that to assign 10 per cent of poverty and crime to the direct effect of alcohol would be a very conservative estimate.

Alcohol and National Efficiency.—To sum up, it is clear that alcohol has done a great deal of harm to some people and a certain amount of harm to a great many people. The fact that some unfortunates might be ruined by this drug has made us all want to keep the danger out of their way.

No man who wants to do anything difficult, and to do it well, would use alcohol beforehand. No surgeon about to perform a difficult operation would dream of taking a drink. No athlete would think of drinking before running a race. When a person wants to be at his *best*, to have his nerves and muscles and his whole body working most smoothly and effectively, he does not use a drug.

So it is with nations. The evil effects of alcoholic drinks upon national efficiency, and the wastefulness involved, were strikingly recognized in the World War. The Russian government stopped the sale of vodka (the Russian strong drink), and the governments of France and England passed laws to restrict drinking. As soon as the European nations wanted to be at their best, to meet a great crisis, they laid aside the burden of alcohol.

At a public meeting held on March 9, 1916, David Lloyd George, the great English statesman, then head of the government department engaged in organizing the manufacture of munitions, made a remarkable statement about

the alcohol problem. He said: "It will be so much better to settle this question by general consent. If we do, the war, horrible as it is, will have paid for itself. There are many

Fig. 70.—A Saloon transformed into a Life Saving Station. With the passage of the Prohibition Amendment which abolished the sale of alcoholic liquors in the United States, many people began to ask what should be found to take the place of the saloon. The Nurses Settlement in New York answered this question in one instance by turning an old saloon into a Health Center from which nurses go out to care for the sick and to teach the rules of health to the nearby community.

things which I hope we can accomplish through this war. There are many changes at home, changes in the outlook of the nation, changes in its temper, changes in its attitude of

mind, changes in its industries; but this will be the greatest and most beneficent change of all if we succeed in carrying it through. If we can possibly convince the nation that success depends very largely upon removing this drag on its efficiency, then I feel confident that we shall regard this as our greatest triumph."

In the United States, as in Europe, the critical conditions of the World War demanded action on the alcohol problem. We have seen that scientific investigations and practical business experience had made it clear before 1917 that alcohol was a foe to national health and to national efficiency. When the United States entered the war in that year, the time had come to act. The first step was to forbid the use of alcoholic liquors by men in the uniform of the army or navy. The second step was inspired particularly by the waste of valuable food materials involved in the manufacture of beers and distilled liquors; it consisted in the stoppage of brewing and of the manufacture of spirits on December 1, 1918. The third of these war measures established universal national prohibition, to go into effect July 1st, 1919, and to continue until demobilization of our armies was completed. Meanwhile an amendment to the Constitution of the United States, providing for permanent nation-wide prohibition, had received the approval of three fourths of the states of the Union, to go into force January, 1920, and the United States thus became a prohibition nation.

Dangerous Medicines.—It is important to remember that both alcohol and many harmful and habit-forming drugs are often taken unknowingly in various kinds of patent medicine. Some of the commonest and most widely advertised "tonics" and "spring medicines" owe any effect they have

to the fact that they are composed largely of alcohol. Remedies supposed to cure catarrh, tuberculosis, and other diseases often contain opiates that may lead to a drug habit. Medicines advertised to soothe babies usually contain morphine or opium, and headache cures frequently contain deadly poisons, such as acetanilide. No one should ever use such preparations without first consulting a physician. The well person has no need of drugs of any kind, and if one is ill enough to need drugs, he is ill enough to benefit by

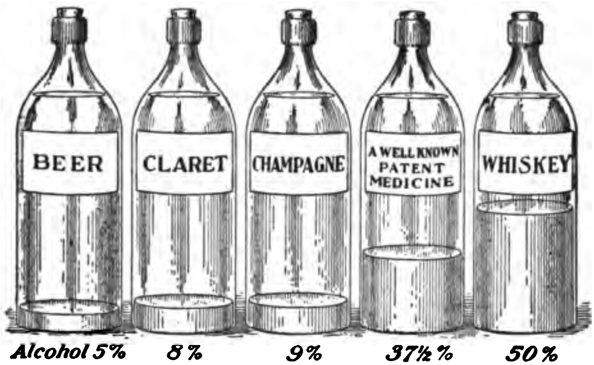

Fig. 71.—Relative amounts of alcohol in certain intoxicating liquors and in a popular patent medicine.

medical advice. Very often the physician will not suggest medicines at all but a change in food, more rest or exercise, or some other precaution in the way of hygienic living.

The Tobacco Habit.—Tobacco is not a habit-forming drug in the sense that opium and morphine are, but it is somewhat like them, since people who smoke are very likely to get into the habit of smoking more and more. The effects of tobacco, when used by grown people, are much less serious than those of alcohol, though tobacco contains nicotine and other poisons in small amounts. The digestion

and the action of the heart may be seriously affected, however, by smoking. The hand of a confirmed smoker often trembles from the effect of tobacco on the nerves, and youths who smoke are generally considered unreliable in their work, so that many people will not employ them.

As in the case of alcohol, the cost of tobacco is, in the aggregate, a serious burden on the economic resources of the nation.

Tobacco is especially harmful to young people, and no boy under twenty who cares for his health and strength and success in after life can afford to handicap himself by the use of cigarettes.

Statistics gathered in many different schools and colleges have shown that boys and young men who smoke make a worse showing in their studies than do non-smokers. Professor F. J. Pack, in a study of the scholastic records of a group of football players, found that 101 non-smokers had marks averaging 79.4, while the marks of 81 smokers averaged 74.5. In another series of cases, 82 smokers had 70 conditions and failures, and 98 non-smokers had 43.

Dean Briggs of Harvard says, "The peculiar evil in cigarettes I leave for scientific men to explain; I know merely that among college students the excessive cigarette smokers are recognized even by other smokers as representing the feeblest form of intellectual and moral life."

Questions for Discussion and Review

1. What did we learn about the effects of alcohol on the heart and the blood vessels? On the kidneys and the liver?
2. What mistaken idea do some people have about the effect of alcohol on the bodily machine?
3. To what organs does alcohol do the greatest harm?

4. In a telephone system, if the wires are interfered with, the messages are either confused or lost, and everything depending upon that system is upset. Compare this with a nervous system under the influence of alcohol.

5. Recall the use of inhibitions. Give an example. Suppose that these inhibitions were temporarily removed by the influence of alcohol. What would be the result?

6. Give an example (not in the text) of a force which is valuable when controlled, and dangerous when turned loose.

7. In the story of the rifle clubs (page 174), why could not the men frequent saloons and shoot well? Do you think that this would apply to basket ball or football?

8. Describe Professor Benedict's experiment to test the effect of alcohol on quickness and accuracy. What does this show?

9. How does the use of alcohol cause accidents in traffic and in industry?

10. Do you think an employer had a right to say that the men he employed should not drink intoxicating liquors?

11. Make a list of the effects of alcohol which endanger a man's health. Make a list of those which make him a poor citizen and an undesirable employee.

12. Are the physical effects of alcohol permanent or temporary?

13. Two men had to make an important business decision. One went to bed early the preceding night. In the morning he took a quick cold bath and a good rubdown, ate a light breakfast, and walked to his appointment. The other stayed up late to prepare his arguments, slept poorly because his brain was over-tired, rose rather late, and hurried to the appointment. On his way he took a drink to brace himself for the meeting. Apparently the two men were in equally good condition. Whose judgment would you be more willing to trust? Give your reasons.

14. Discuss some of the principal items in the cost of alcohol.

15. Why did America adopt the Prohibition Amendment to the Constitution?

16. Why is it important that all medicines be plainly and truthfully labelled, to show what they contain?

17. What are some of the evils of the tobacco habit?

18. In what ways does smoking affect one's efficiency?

CHAPTER XVI

THE SENSE ORGANS

How We Learn What Goes on about Us.—The nervous system not only keeps all the different parts of the body working together, but constantly regulates and alters their activities to meet conditions in the world outside. We are all the time looking up to see something, reaching out to grasp something, listening to hear something. How does the nervous system get the messages from the outside world which enable it to do this work so quickly and accurately?

Have you ever noticed the queer things that children do when they are playing blindman's buff or trying blindfolded to pin the tail on the donkey? Have you ever tried to do for five minutes with your eyes shut any of the things you do in your daily life? It is easy to see in this way how dependent we are upon our eyes. But the eyes are not the only doors through which messages enter the brain. With our eyes shut, we can still hear, feel, taste, and smell. We can hardly imagine what the world would be like to us, if all these senses were taken away.

There are many different senses by which we learn what is going on about us, but five of them are so much more familiar than the rest that they are generally called the *five senses*. These are **sight, hearing, taste, smell,** and **touch.**

The Senses Compared to the Telephone.—In the ordinary telephone, there is at one end an instrument called the transmitter, into which a person speaks, and at the other end an instrument called the receiver, which another person

holds to his ear. A wire runs between these two parts. In our bodies, the brain and spinal cord correspond to the receiver; the sense organs—such as the eyes and ears—are like the transmitter; and the nerves run between these parts, like the wires. The sense organs respond to light or sound or some other influence from outside, and pass on a message that is sent up along the nerve to the spinal cord or brain.

The Structure of the Eye.—The eyes are in some ways the most beautiful and most useful of all the sense organs of the body. They teach us the greater part of what we know about the world. Through them we perceive the beauty of sun, trees, and flowers, and through them we are able to learn what people in other ages have thought and done, by looking at the things they have made and reading the books they have written.

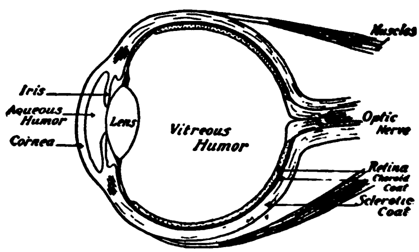

Fig. 72.—The structure of the eye.

The eye (as shown in Fig. 72) is somewhat like a camera. In the front is a transparent **lens,** which makes a little picture at the back of the eye, just as the lens in the camera makes a picture on the film or plate, by bending the rays of light that pass through it. The lens in the eye is not hard like glass, however, and its shape can be changed so as to make it flatter or rounder, by the pull of tiny muscles and membranes attached to it.

At the back of the eye is the **retina,** which corresponds to the sensitive plate in the camera. There the light sets up chemical changes that make the picture. Color blindness,

or the inability to distinguish certain colors (usually red and green), is due to the lack of substances which are found in the normal retina.

In the retina, the picture of what we are seeing is changed into a nerve message which passes to the brain by way of the large **optic nerve.** By means of this nerve message, and the connections that it makes in the brain, we *know* what the picture is that is formed on the retina. It is with the brain that we really see consciously, and in the brain the messages brought from the eye are passed on from one nerve cell to another till they lead to action. The picture on the retina would be nothing but a dead picture without the nerve and brain behind it.

The most important parts of the eye, the lens and the retina, are inclosed in a nearly spherical eyeball. There are three coats or layers in the wall of the eyeball, the **sclerotic** (sklē rŏt′ĭk) coat, the **choroid** (kō′ roid) coat, and the retina itself.

The sclerotic is the tough outside coat which incloses the whole eyeball, except where the nerve passes in at the back. It is white in color, except in the middle of the front of the eye, where it becomes transparent. This transparent window is the **cornea.** The part of the sclerotic coat around the cornea is what we call the white of the eye.

Inside the sclerotic lies the choroid coat, which has a circular opening in front, opposite the middle part of the cornea. The part of the choroid coat around this opening forms a kind of curtain, called the **iris,** which can be expanded so as to make the central opening smaller, or drawn back so as to make it larger. It is the iris which we see as a colored ring when we look into a person's eye (the part which makes the eye black or blue or brown). The dark

central opening, the **pupil**, is the opening behind the cornea by which the light passes to the lens.

The large space behind the lens is filled with a transparent jelly-like substance called the **vitreous humor;** the space between the lens and the cornea with a watery fluid, the **aqueous humor.**

How the Eye Accommodates Itself to Changing Conditions.—In a dark room the **iris** is drawn back so that the pupil is very large. In a bright light it shuts in, as if it were drawn by a puckering string on the inside edge, and makes the pupil smaller and smaller. In this way the amount of light that enters the eye is regulated. When you go into a dark room, you cannot see clearly till the iris has had time to open and let in more light.

If you have ever taken photographs or watched some one else taking them, you know that the camera has to be **focused;** that is, it has to be adjusted a little, according to the distance of the thing to be photographed. When you have taken a picture of an object near at hand and then want to take one of a building some distance away, you have to focus, by moving a screw which changes the distance between the lens and the plate. The eye has to do somewhat the same thing. Look at a pencil a few inches from your eyes and then look quickly to the other end of the room. For a second, while your eye is focusing, everything will look blurred.

In the case of the eye, this focusing is done, not by changing the distance between the lens and the retina, but by a change in the shape of the lens itself. When the eye is at rest or looking at something a long way off, the lens is quite flattened; but when we look at an object near at hand, tiny muscles in the eye contract in such a way that the lens

becomes more rounded. Rays of light are bent by a flat lens so as to make a picture of far-off objects, and by a more curved lens, so as to make a picture of things near at hand. This adjustment of the eye which is necessary when we change from looking at things far off to things near by, or the reverse, is called **accommodation.**

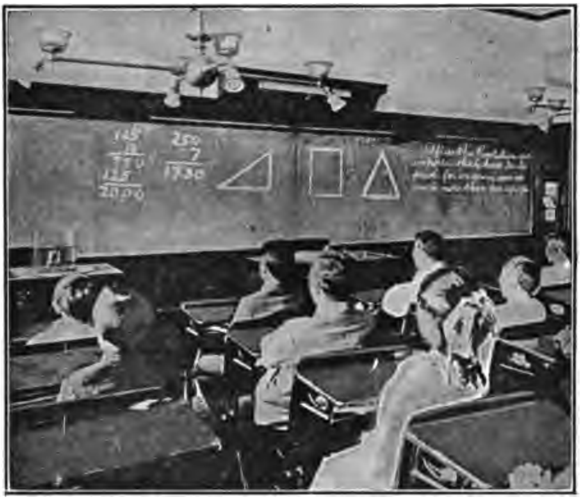

Fig. 73.—How the schoolroom looks to the normal child.

The Protection of the Eye.—The eye is very carefully protected by a deep socket-setting with a bony ring around it, by a soft lining of fat, and by the eyebrow above. It is also protected by the eyelid, a fold of skin which helps to keep out too much light, and which closes instantly at any sudden motion that seems to threaten injury. The eyelashes help to guard the eye from dust.

The Lachrymal Gland.—In the outer corner of each eye is the **lachrymal gland,** which pours out a liquid to wash the

eye and keep it clean. Ordinarily this liquid is formed very slowly, and after passing across the eye is carried off by a small channel into the back of the nose. Sometimes, if a person is angry or hurt or sad, a reflex nervous action causes the lachrymal gland to secrete very rapidly. The liquid gathers in the eye and overflows, and we call it tears.

Fig. 74.—How the schoolroom looks to the near-sighted child.

The Function of Eyeglasses.—The eye is a complicated organ and in many people it does not work perfectly. In order that we may see clearly, the lens must focus, or form its picture, exactly on the screen of the retina. In some eyes the lens is curved too little, or is too close to the retina. People with such eyes cannot see things near at hand without effort, in spite of the contraction of the eye muscles; we call such people **far-sighted.**

Other people have lenses that are curved too much. They can read a book in their hands but cannot see a blackboard

across the room clearly. Such people are said to be **near-sighted.**

Another kind of eye trouble, called **astigmatism,** is caused by an irregular shape of the cornea or of the lens, which bends the light rays so that they do not come to a clear focus.

O F L C

A P E O R

N P R T V Z B

Fig. 75.—A test of vision. The upper line of letters should be read at 30 feet, the middle line at 20 feet, the lower line at 15 feet.

Sometimes a child seems to be stupid just because his eyes have some of these defects and he does not see clearly. If one keeps on trying to see with eyes that do not focus well, the muscles of accommodation are constantly strained, and bad headaches or nervousness or other troubles may result. All such difficulties may generally be cured at once by the use of eyeglasses. The lenses in the eyeglasses are shaped so as to correct the defects of the cornea and lens by bending

the light rays so that they will make a clear picture. A good oculist can find out just what is wrong with the eyes and have a pair of glasses made to correct the trouble. With the right kind of glasses, a person can see clearly and without constant strain on the focusing muscles.

The use of eyeglasses often makes a wonderful change in a child's life, makes him better at school work and in games, and cures him of headaches and other troubles that were due

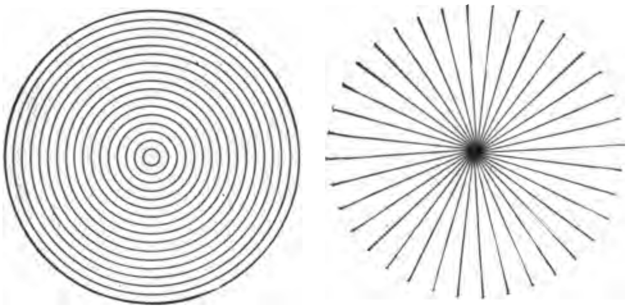

Fig. 76.—With one eye closed, look at either of these figures. If the lines appear blurred, astigmatism is present.

to weak eyes. If you have to hold a book very close to your eyes when you read, if the writing on the blackboard does not look distinct to you, if you have headaches, if your eyes hurt you after you have been reading for a while, or if they are red and inflamed, you should have them examined.

The examination of the eyes should always be made by a physician trained in this work (an oculist) and not in an eyeglass shop, for only a physician can do the work properly. Eyeglasses that are not just right will do more harm than good and may seriously injure the eyes. It is a good plan, as a precaution, to have the eyes examined about once a year, whether they are known to give trouble or not.

Examinations of the eyes of children in certain schools have shown that one out of every five needs eyeglasses.

Some of the Ways in Which Eyes are Strained.—Whether we wear glasses or not, it is important to remember not to strain the eyes by using them too long at a time for close work, or by trying to read, sew, or do any other fine work in a poor light. Children often hurt their eyes by reading in the late afternoon when the light is failing. Too bright a light may be just as bad as too dim a light; and it is harmful to read with sunlight or lamplight glaring into the eyes or reflected directly from the paper. If you cannot see the writing on the blackboard clearly or if there is a glare of light in your eyes, you should ask to have the shades drawn up or down, or perhaps to have your seat changed.

When one is reading, writing, or sewing, the light should come from the left side and from above, because in this way less shadow is cast on the work by the active right hand. The book or work should always be held at least twelve inches away from the eyes.

A flickering, unsteady light is very trying, and reading on trains or cars is often harmful for this reason. We should not read when lying down, for this makes the eyes work in an unnatural position and always strains them.

If cinders or other foreign bodies get into the eyes, it is well to ask an older person to help you remove them.

The Ear and Its Functions.—When a stone is thrown into the water, waves spread out from it in all directions. When a person calls out, when a bell rings, or when any other noise is made, waves of air are produced which are somewhat like these water waves. They are called **sound waves.** We cannot see them with the eyes or feel them with the

hands, as in the case of the water waves, but the ear is made in such a way that it is affected by them. There are only certain kinds of sound waves that the ear can catch, and people vary somewhat in their power of detecting them. The cry of the bat, for instance, is so shrill that some people cannot hear it at all.

The ear which we see on the outside of the head is just a kind of trumpet to catch the sound waves, and is not the

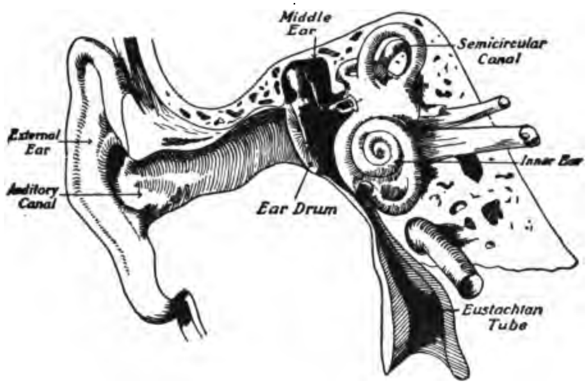

Fig. 77.—The structure of the ear.

real organ of hearing. It opens into a tube, at the end of which is a thin membrane called the **ear drum.** On the other side of the ear drum is a space called the **middle ear,** and beyond this is the **inner ear,** another curiously shaped space filled with liquid.

When sound waves come into the outer ear, they make the delicate ear drum quiver. This moves a chain of three little bones that stretch from the drum across the middle ear. These bones carry the motion along to the fluid in the inner ear, where the nerves of hearing are situated, and where the

movement of the fluid causes messages to pass along these nerves to the brain.

From the middle ear there is an opening called the **Eustachian tube,** which enters the back of the throat. After a cold in the head, germs sometimes work their way up through this tube into the middle ear and cause serious disease and sometimes deafness. Pain or rumbling in the ears or discharge from the ears are signs of danger, and indicate that a good physician should be consulted. If a person has any reason to suspect that his hearing is not good, the source of the trouble should at once be sought.

Wax in the ears is entirely normal. It is formed by small glands in the outer ear and helps to guard the approach to the ear drum. It should not be removed except when too much forms, and then only by a physician, as digging into the ear with pointed instruments may injure the delicate drum.

The Organs of Taste and Smell.—There are many other organs of sensation in the body, much smaller and less familiar than the eyes and ears,—the organs of taste and smell, for example.

If you look at your tongue closely in the glass, you will see many little ridges like tiny mountains and valleys covering the whole upper surface. The organs of taste, called the **taste buds,** are situated in these little valleys. They are tiny rounded masses of cells, sensitive to the taste of certain substances. The organs of smell are similar groups of sensitive cells with nerve connections, situated in the upper part of the nose. They are affected by different substances from those which affect the taste buds.

It is with the sense organs of the tongue that we taste and distinguish sweet and salty things, sour and bitter things;

but most of the flavors of food which we call "tastes" are really smells, perceived by the sense organs in the nose. (You remember that the nose and throat are directly connected by an opening at the back of the throat.) If you hold your nose so that no air can get up to these sense organs, most of the flavors of the things you eat will not be noticed at all. Sometimes during a severe cold in the head, when there is difficulty in breathing through the nose, these so-called tastes, which are really smells, are almost lost.

The organs of smell are perhaps the most marvellously delicate sense organs of the body. Particles carried by the air, so small that they cannot be seen, upon coming in contact with these organs of smell will make one aware of odors. A bowl of dried rose leaves may stand in a room for a long time without losing enough of their substance to be detected by weighing on the most delicate scales, yet through all that time microscopic amounts of fragrant substances have been given off from the rose leaves and have affected the sense organs of the nose, so as to send an impulse up the nerves and produce in the brain the sensation of their characteristic odor.

Other Sense Organs.—Scattered over the surface of the body are tiny end organs of the nerves with which we feel the touch of things, and others by which we distinguish heat and cold.

These three kinds of sense organs appear to be distinct, some perceiving heat only and some cold only, while others serve for what we ordinarily call feeling. If careful studies are made of the power to feel very small hot and cold objects, it is found that only certain areas of the skin (having cold sense organs) are sensitive to cold, while others (having heat sense organs) are sensitive to heat. Sense organs of

touch are particularly numerous in some parts of the skin. The ends of the fingers, for instance, have a delicate sense of touch, but on the back and shoulders the sense of touch is very imperfect. If two blunt points an inch apart are placed on the back, you cannot tell whether two points or one are touching you.

There are various other sensations—such as the sensations of *position*, *pain*, *hunger*, and *thirst*—all of which are felt by means of nerves connected with special sense organs in various parts of the body.

Questions for Discussion and Review

1. By what means do we learn what is going on in the world about us?

2. Try this game. Place a person at one side of a large room, and tell him to look directly across at a certain point on the other wall. While he is looking, blindfold him, and then have him walk to the point indicated. Watch and see how reliable a guide his muscles are. If some one stood at the point of destination and spoke to the blindfolded person, what difference would it make?

3. Name the special sense organs. Which of them seems to you the most valuable?

4. What is the name of the outer coat of the eye? The middle? The inner? Describe each.

5. Stand beside a person and look across the front of his eye. What is the transparent, slightly convex window which you see?

6. What part of the eye regulates the amount of light that enters the eye? To what part of a camera does this correspond?

7. Why is it that when you first go from a brightly lighted room into a dark room you cannot see so well as you can after you have been in the dark room a few moments?

8. Have you ever tried "bending" a ray of light with a mirror? With a prism? A lens? What happens to the rays of light when you start a fire with a burning glass?

9. In a camera, what does the lens do? How do you focus the lens so that the picture is formed clearly on the plate or film?

10. Where must the picture be formed in the eye, in order that it may be seen clearly?

11. How is the lens in the eye changed in focusing for different distances?

12. Stand at a window and look at the glass, or better still at the window screen. Then look in the same direction at some point as far away as possible. See how the screen, or any mark on the glass, disappears. Look alternately at the screen and away, until you can feel the difference. What is happening in your eye? What name do we give to it?

13. What must happen in the eye and behind it, in order that the brain may be conscious of the picture on the retina?.

14. In what ways is the eye protected from injury?

15. What is the function of tears? Where do they come from and where do they go?

16. What do we mean by near-sightedness? Far-sightedness? Astigmatism? What are glasses for?

17. How can poor eyes make a child seem stupid? Does a child always know that he is not seeing as well as he should? How may such cases be tested?

18. What are some of the indications of eyestrain? Should we wait for eyestrain to appear before we care for the eyes?

19. If a person has to bring his work nearer than twelve inches from his eyes, what is probably the matter?

20. Why is it harmful to the eyes to read on a train? By firelight?

21. Make a set of rules for the care of the eyes. Also a set of "Don'ts."

22. What is sound? Do sounds exist which the human ear cannot hear?

23. What is the ear that we see on the outside of the head? What separates the outer ear from the middle ear?

24. How do the vibrations from the air reach the middle ear? Explain the arrangement whereby these vibrations reach the nerves of hearing and, finally, the brain.

25. What is the Eustachian tube? How does it sometimes become a source of danger?

26. Of what use is the sense of taste? Where are the organs of taste located? What influence does taste have on digestion?

27. Of what practical use is the sense of smell? How do the senses of taste and smell overlap one another? Give examples of so-called sensations of taste which are really sensations of smell.

28. How do blind people make the sense of touch take the place of sight? Find out all you can about Helen Keller. She was blind, deaf, and dumb because she could not hear, but she learned to talk, and has gained a good education.

PART TWO

CHAPTER XVII

GROWTH AND DEVELOPMENT

The Development of Living Things.—One of the most interesting peculiarities of living things is that they all go through a regular and definite course of changes, forming a **cycle,** or circle, of development. Sometimes these changes

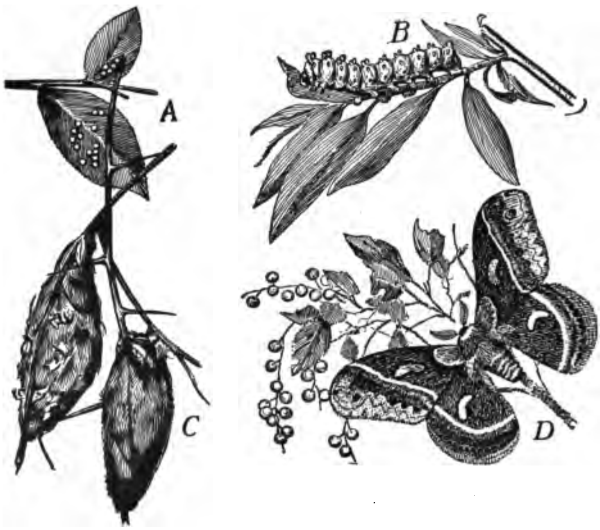

Fig. 78.—The life cycle of an insect: A, egg; B, larva; C, pupa; D, adult.

are quite complicated. For instance, from the egg of a butterfly there comes, not a butterfly, but a caterpillar or larva. The caterpillar grows, and at last changes into a pupa (pū′ pȧ), or resting stage (the chrysalis), and from this chrysalis the new butterfly comes out.

The changes are often much simpler than this; but it is always true that the young of any living thing is different from its parents, and that it goes through a definite series of changes until it arrives at maturity.

Growth and Development.—After a child is born, it is weak and helpless, wholly dependent upon its parents.

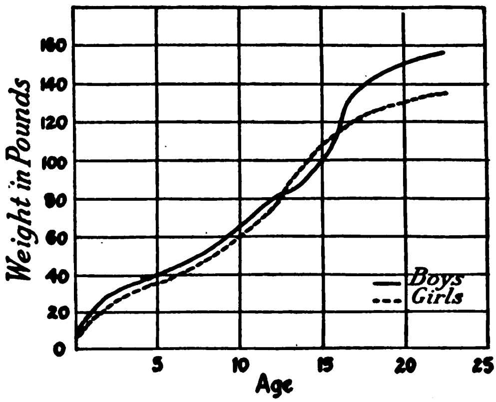

Fig. 79.—Average weights of boys and girls at different ages.

From any age on the bottom of the graph, read up to the curve and then from that point on the curve read to the left, to learn the weight at that age. Thus, a girl of 10 should weigh, on the average, 60 pounds.

Then slowly, day by day, week by week, and month by month, it grows in size, weight, strength, and intelligence. It learns to creep and then to walk, to coo and then to speak, and becomes in time an active, romping boy or girl, and finally a full-grown man or woman, in possession of all the powers of maturity.

The average rate of growth in height and weight, calculated from the measurement of a large number of chil-

dren, is shown in Fig. 79. At birth, as a rule, the baby weighs six or eight pounds and is less than twenty inches long, about one-twentieth of its weight when full grown and less than a third of its final height. By the end of the first six months, the child's weight has doubled. By the fifth year, he weighs on an average forty pounds, by the tenth year sixty, and by the fifteenth year one hundred pounds. The growth, as you see by the diagram, is very rapid at first, and the per cent of increase grows less and less, as is indicated by the flattening of the curve.

Growth as a Measure of Health.—The growth of a child is a reasonably good measure of its general health. Failure to reach the weight which is normal for a child of a given age and height is a sign that something is wrong. On page 384 are given tables showing normal weights of boys and girls. Children who are much below these normal weights can often gain in health and vigor by improvements in diet or other measures of personal hygiene.

Youth, Maturity, Old Age.—For the first twenty or thirty years, the child and the young man or woman are growing bigger and stronger physically and mentally.

From thirty years to fifty years, the man or woman is in the full prime of mature life and vigor. The wasting away of the body, which goes on all through life, is overbalanced in youth by the growth of new living tissue, but in the prime of life it is about equalized by the building-up process. At forty-five or fifty years of age, the wasting away begins to be greater than the growth. The walls of the blood vessels harden and lose their elasticity, and the kidneys do not work so well as in youth. After this, though the mind may be at its best, the rest of the body is less vigorous, and finally old age comes on.

Hygiene in Relation to Youth and Old Age.—Healthful habits are particularly important in youth, because it is during this period that the strength and beauty of the mature body are usually determined. If a child gets poor food or not enough food, he will never grow to full height and strength. If he does not live much in the open air and sleep with windows open, he will be liable to colds and diseases of the lungs and throat. If he does not exercise, his muscles will not grow strong. If he forms the habit of slouching, he will find it hard to carry himself well when he grows up. If he gets into nervous and fretful habits of mind, it will be difficult for him to get out of them in later years.

Just as the habits of youth have much to do with health and happiness in mature life, so the habits of both youth and mature life have much to do with the coming on of old age. Most people grow old too soon. There is an increase year by year in the diseases of adult life. The way to keep well and strong as long as possible is to form and retain habits of healthy living.

Effects of Tobacco on Growth.—It is commonly believed that the use of tobacco by boys has a definite effect in stunting growth. Some years ago, Dr. Seaver of Yale made a comparison of the physical development of smokers and non-smokers during the four years they spent at college. He found that the students who did not use tobacco gained 10 per cent more in weight, 24 per cent more in height, 27 per cent more in chest expansion, and 77 per cent more in lung capacity than did the smokers.

It should be remembered, in such a comparison as this, that many things besides smoking may have some effect on the results. For instance, athletes are not allowed to smoke

while in training, and being men who lead a healthy outdoor life, are certain to develop well. The boys who smoke in college, on the other hand, are very likely to do other things that will injure their health.

We are quite sure, however, that tobacco affects the digestion, the heart, and the nervous system, particularly when used by young people, and these unfavorable effects naturally react upon growth and development. It is certain, also, that smoking has some effect on "the wind" (really, as we have seen, on the heart) which unfits a boy for athletic success, and that its effect on the nervous system lowers the power of concentrated mental work.

It is for these reasons that most state laws make it a crime to sell or give tobacco to boys under a certain age.

Questions for Discussion and Review

1. What hatches from the egg of a butterfly? What is the life cycle of a butterfly?

2. Is there any difference, other than size, between a baby and a full-grown man or woman?

3. Look at the curve on page 204 and see what an average boy should weigh at 3 years of age. At 9 years. A girl at 7 years. At 11 years.

4. Where does the child's body get material from which to grow?

5. What is the difference between the processes going on in the body in youth and in old age?

6. Why is it easier to form good health habits while you are young and growing than after you are full-grown?

7. It is known that smoking injures the digestion, the respiration, and the heart action. What effect would this have on a boy's growth?

CHAPTER XVIII

HABITS OF HEALTH

Health, Strength, and Happiness.—It is interesting to know how the body does its wonderful work. The study of hygiene should result in much more, however, than the storing of your mind with knowledge. It will fail in its main object if it does not lead you to form **habits of health** which will help you throughout your life. You should think of **health** as something splendid and worth while. Health means strength, and beauty, and power to do things well, and cheerfulness, and happiness, and usefulness.

Some children are naturally stronger and healthier than others. If you are one of these fortunate ones, you should make the most of it, and not waste your strength by doing things that harm the body, and so throw away the chances that nature has given you. If you are not naturally strong, remember that you can become healthier and stronger by forming good habits. Theodore Roosevelt was a sickly boy, and became a national example of energy by leading a hygienic life on a western ranch.

When an athlete is going into a race, he trains for it and is glad to pay attention to his body, to get it into the best condition. Life itself is a race, and your success in it will depend very largely on keeping your body strong. It is worth while to form health habits so that you may win in the game of life.

Health is not usually to be gained by taking medicines or tonics. In certain diseases, medicines taken under the doc-

tor's advice are of value; but **self-doctoring** is almost always harmful. When anything goes wrong, a physician should be consulted promptly to see whether special treatment is needed; but a healthy human body can cure itself of many diseases. We can be sure of having a healthy body only by observing the rules of personal hygiene, particularly in regard to food, fresh air, exercise, and rest, and by avoiding poisonous drugs and stimulants.

Let us now review some of the important principles of health which have been discussed in the earlier chapters.

Food and Health.—The body cannot grow strong, if it does not get enough food to build itself up. On the other hand, overloading the stomach with more food than it needs is almost as great an evil. People are realizing more and more the importance of knowing what foods to eat and in what combinations and quantities. They are thinking more and more, also, about the relative cost value of the nourishment that different foods supply. When you grow older, you will learn more fully than you can in this course how much food value different foods give the body and what they cost, and with this knowledge you can buy food so as to get the most for your money.

The kind of food is just as important as the amount. An excess of rich food or fried food, or too much candy, will harm the body. Too much of the protein foods—meat, fish, and eggs—is bad. The diet should be simple and varied. Milk is one of the best of foods, provided it is clean and pure. Fruits and green vegetables contain things that the body needs and cannot get easily from other sources. Every one should eat some hard and coarse foods, like oatmeal and brown bread.

All foods should be chewed thoroughly before being

swallowed. Bolting the food puts an extra burden on the stomach and makes one lose the pleasure and the safeguard that come from the exercise of the power of taste.

Air and Health.—A second important factor in keeping healthy is fresh air. A current of fresh air bathing the body keeps the blood vessels of the skin healthy, makes one feel active and strong, and encourages appetite. People who live in the open air are much less likely to have colds, pneumonia, and tuberculosis, than those who shut themselves up in overheated rooms. It is best never to stay any longer than necessary in a room that is warmer than 70°. One should be out of doors as much as possible and should always sleep with windows open.

Too much cold, on the other hand, may be harmful. It is especially bad to sit or lie still (without sufficient covers) in a cold room, to sit with wet feet or clothing, or to be exposed to a draft after the body has become heated so that it is perspiring.

Clothing and temperature should be adapted to each other, and wraps should be put on or off so as to avoid chills or overheating.

Exercise and Health.—The muscles of the body may be developed surprisingly by proper use, and on their development the health of many organs directly depends. A slouching boy or girl with half-used lungs and flabby muscles is never thoroughly healthy.

For the sake of strength, beauty, and health, one should learn to hold the body well, to support the upper part of the body from the hips, and to sit and stand straight, with stomach in, chest out, and head up.

The only way to keep the lungs healthy is by exercising them, by breathing deeply and keeping the chest ex-

panded and the small lung passages at work and filled with air.

Habits of regular physical exercise are necessary to keep the muscles healthy. Special exercises in the gymnasium will develop weak parts, and it is also desirable for every child to learn to play some outdoor game, so that when he grows up it will be a never-failing source of pleasure and

Fig. 80.—A good outdoor game develops the mind and the character, as well as the body.

recreation. Baseball, basket ball, tennis, skating, swimming, riding, rowing—every boy or girl should make some one or more of these sports his friend for life.

Rest and Health.—The muscles, nerves, and all the other parts of the body need rest as well as exercise. Playing rests you when you have been working, but play may be harmful if it is too hard or too prolonged.

Remember that the body needs complete rest or sleep for eight or ten hours a day, according to a person's age.

If work or play interferes with sleep, only one result can be expected—a tired, cross, disagreeable person, who cannot get fun out of life or be of much use to other people.

Keeping the Body Free from Wastes.—Getting rid of the wastes of the body is as important as supplying it with the food it needs, for wastes poison the body, whether they are food wastes in the intestines or wastes from the life process in the body itself. The body is helped greatly in getting rid of its wastes by free perspiration, and hard exercise that makes one perspire is an important factor in good health.

It is very important that the wastes from the intestines should be removed regularly at least once a day, in order that poisons may not be absorbed into the body. Drinking a glass of water on rising, and eating oatmeal and fruit and other bulky foods for breakfast, help to secure this result.

Hygiene of the Mouth.—The mouth is the gateway of the body, and its protection against dirt and disease is one of the first essentials of hygiene. In later chapters we shall read about keeping contaminated foods, dirty fingers, and other harmful things out of the mouth; but the mouth itself needs constant care, to prevent harm from the microbes always present there. Decayed teeth, which result from a neglected mouth, not only mean suffering, but open the way for many serious diseases of the whole body.

The regular and thorough use of the toothbrush at least twice a day, and better still after each meal, will do a great deal to prevent painful visits to the dentist and premature loss of teeth.

Avoidance of Drugs and Stimulants.—No athlete in training is allowed to use alcohol or tobacco or any other

drugs or stimulants. Without exception, these things make people less efficient physically and mentally. Many of them are habit-forming; that is, the body which has learned the unnatural taste wants more and more. It becomes harder and harder for the slave to the alcohol, tobacco, or drug habit to get free and live a healthy life again. They are all poisons, which in time do serious harm.

The wise man or woman keeps in training all the time, so as to be as healthy as possible, and uses no drugs or

Fig. 81.—Four of your best friends.

stimulants of any kind, for they do no good and always harm the body in the long run. The safest and easiest thing to do is to let them entirely alone.

Discovering Physical Defects in Time.—If each one of us started out with a perfect body and lived an absolutely hygienic life, there would be little need for doctors. Not one of us has a perfect body, however, and not one of us always treats his body just as he should. Something is sure to go wrong now and then; tonsils become diseased, teeth decay, or eyes need glasses.

These physical defects can be cured if they are taken in time, but if they go on too long they may become serious. The purpose of regular medical examinations is to discover anything that is going wrong, before it is too late to remedy it. Such examinations are very necessary, especially for children, whose whole future health may depend upon having defects discovered in time.

Most schools now have a special school doctor to do just this thing—to examine eyes, ears, throat, teeth, chest, and other organs occasionally, and to find out what ought to be done to keep them in good condition. In many schools there is also a school nurse to help examine the children and to visit the homes and tell the parents what treatment the children need.

Fifteen Rules of Health.—The manual *How to Live*, prepared by Professor Irving Fisher and Dr. E. L. Fisk for the Life Extension Institute of New York, summarizes some of the most important principles of personal hygiene in the following excellent rules:

I. AIR:

1. *Ventilate every room you occupy.*
2. *Wear light, loose, and porous clothes.*
3. *Seek out-of-door occupations and recreations.*
4. *Sleep out-of-doors, if you can.*
5. *Breathe deeply.*

II. FOOD:

6. *Avoid overeating and overweight.*
7. *Eat sparingly of meats and eggs.*
8. *Eat some hard, some bulky, some raw foods.*
9. *Eat slowly.*

III. Poisons:

10. *Evacuate thoroughly, regularly, and frequently.*
11. *Stand, sit, and walk erect.*
12. *Do not allow poisons and infections to enter the body.*
13. *Keep the teeth, gums, and tongue clean.*

IV. Activity:

14. *Work, play, rest, and sleep in moderation.*
15. *Keep serene.*

Questions for Discussion and Review

1. No amount of *knowledge* is of any value unless it is put to use. How does this apply to the study of physiology?

2. Why do *you* want health? Even if you didn't care anything about health yourself, what do you owe to other people which should make you work to gain it?

3. Which should try harder to develop good health habits, the child who is naturally well and strong or the child who is inclined to be sickly?

4. What good habits can you form with regard to food and health? Can eating between meals become a habit? Why is it harmful?

5. Examine your present habits. Have you the ice-cream soda habit? The candy habit? Do you eat too much dessert and too few vegetables? Do you take a mouthful of milk or water to "wash down" food? Do you chew your food? Do you eat fast? Do you hurry through your meals to get back to play or to school, or do you spend a little extra time at the table talking and laughing?

6. If a person becomes accustomed to work and play indoors all the time, he does not enjoy the open air. What harm will result?

7. The girl or the boy who plays outdoors in cold weather

without heavy wraps, because it is "too much bother" to put them on, is in danger. Why?

8. Why do people who have learned to sleep and live outdoors feel suffocated in a closed place? Are they better off than the people mentioned in Question 6?

9. Why should boys and girls learn to swim, row, ride, and skate, and to play such games as baseball, basket ball, and tennis?

10. Why are regular sleeping hours necessary? What is likely to be the result if schoolboys and girls go to evening parties, theaters, and moving picture shows during the week?

11. What is the duty, in the great health campaign, of every boy and girl who has learned about the evil of habit-forming drugs and stimulants?

12. Why is the mouth the easiest gateway of disease? How should it be guarded?

13. What habits should we form in the care of the teeth?

14. Is it good for one to think about the body and health all the time? How will good health habits make that unnecessary?

15. Why should children who are apparently well be examined from time to time by a doctor?

16. Do the *Fifteen Rules of Health* seem to you to cover all necessary health habits?

CHAPTER XIX

MAN AND THE MICROBE

The Art of Sanitation.—So far, we have, for the most part, been studying about the body itself and the way to use it so as to keep it in good health. Some diseases come, however, not primarily from any careless use of the body or any natural weakness in it, but from some cause entirely outside, as when one has "caught" measles or scarlet fever or some other disease. The work of guarding against these diseases that come from outside, keeping water and food pure, and preventing the spread of communicable diseases from one person to another, is called **sanitation**.

A great deal has been learned by scientific men in their laboratories about the working of the body itself, but the most remarkable discoveries have been made in this field of sanitation—discoveries that have given us protection against many dread diseases and have saved millions of human lives.

Communicable Diseases.—The diseases with which sanitation deals are those known as **communicable diseases.** Diphtheria, scarlet fever, measles, whooping cough and influenza, are all sicknesses of this kind; so is tuberculosis; so is a common cold. All are alike in certain particulars.

These diseases begin in a very characteristic way. A child may get up in the morning seeming perfectly well. After a while he begins to feel dull and heavy and does not want to work or play. Then he has a headache, perhaps, and grows hot and feverish. He says he is sick, and goes

home to bed. The doctor is sent for. What has happened to change a healthy child into a sick one in a few hours?

Communicable diseases stop almost as mysteriously as they begin, after a regular course of a few days or weeks. The sick person gets worse for a certain length of time and then (if he does not die) he begins to get better and finally recovers. After recovery, he is fairly certain not to have that particular disease again for a while, and in the case of some diseases he will never have another attack.

The most striking thing, however, about diseases of this kind is the fact which gives them their name, "communicable,"—the fact that they are *communicated* or spread from one person to another. The great influenza epidemic that raged in the United States in the fall of 1918 killed over half a million people. What is it that causes a particular disease to spread thus from one person to another, striking down each one in turn almost as fire spreads through a heap of papers?

The Discoveries of Pasteur.—It was Louis Pasteur (pȧs tûr′), the great French scientist (1822–1895), who first found the answer to these questions. In the year 1865 there was great trouble in the districts in the south of France, where many of the people followed a curious industry, the raising of silkworms. Silk is obtained from the cocoon spun by a caterpillar, and the silkworm cultivators must constantly feed and care for these caterpillars up to the time when they spin their precious web. At the period of which we are speaking, there was something wrong with the silkworms. Instead of spinning their cocoons, they stopped eating the fresh green leaves that were brought to them, turned dark-colored, dropped to the ground, and died.

The loss of the silk crop was very serious to the people

who made their living in this way, and Louis Pasteur was called on to help the silk growers. He was busy with his scientific studies and did not wish to leave the work in which he was obtaining brilliant results; he protested that

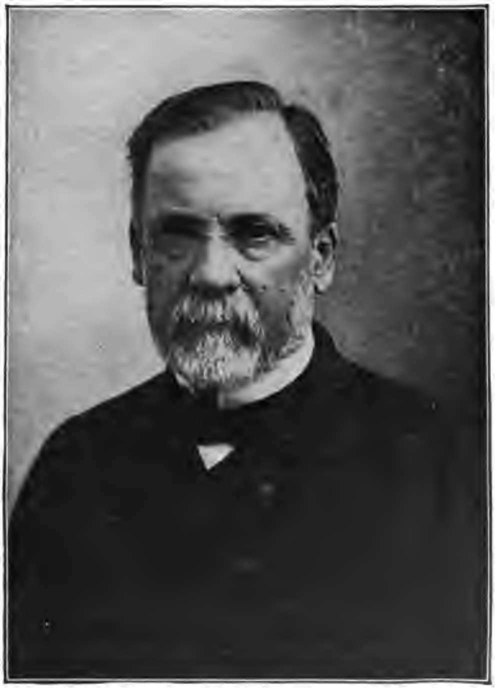

Fig. 82.—Louis Pasteur (1822–1895), founder of the sciences of bacteriology and preventive medicine.

he had never even seen a silkworm. Those who knew Pasteur's keenness and patience insisted, however, that he was the man to solve the mystery, and his patriotism finally yielded to this call for help from one of the great industries of his country. He went to the silkworm district. He dis-

covered in the bodies of the sick worms tiny living organisms that he could just barely see with his microscope. He succeeded at last, after several years of study, in showing that these little organisms were the cause of all the trouble, and he taught the silk growers how to select healthy worms and keep them free from the disease.

Microbes and Disease.—This discovery, as is often the case, led to other discoveries of far greater importance. Pasteur was soon able to show that not only this disease of silkworms, but also diseases of chickens and cattle, and finally of men, were caused in the same way. To-day, thanks to the work of Pasteur and of his followers, Koch in Germany, Lister in England, and many more, we know that all the communicable diseases are caused by **microbes** or **germs,** tiny living plants or animals. It is these living microbes which are spread from one person to another. In the body of each new victim they grow and multiply, very much as a mold grows in jelly, and poison the tissues by the substances they form, as the mold may turn the jelly musty. All through the course of the disease, there is a struggle

Fig. 83.—A famous parasite. A bunch of mistletoe, growing on a gum tree. The mistletoe sends suckers down into the wood and gets its life energy from the sap of the tree itself.

between the invading microbes and the tissues of the body, and when a person gets well it is because the body tissues have at last conquered the microbes.

Parasites.—When any plant or animal lives in the body of some other plant or animal and at its expense, we call it a **parasite.** This was the name the ancient Greeks gave to any one who lived in the house of a rich man and ate at his table without doing anything for him in return. The mistletoe is a plant which grows as a parasite on a tree, sending its suckers down into the wood and sucking out its food from the tree itself. The tapeworm, which sometimes gets into the intestines and lives on the food there before it can be absorbed, so that the person affected almost dies of starvation, is a parasite. The flea, which lives on the blood it sucks out of its victim, is a parasite. But disease microbes are the most dangerous parasites of all.

Activities of Microbes.—The word *microbe* means simply a little living thing; and there are a great many different kinds of microbes which play an important part in the world.

If a glass of milk, a jar of jelly, or a piece of meat stands for a few days in a warm place, the milk sours, the jelly turns musty, and the meat decays. In each case there is a chemical change, called **fermentation** or **decomposition,** and in each case the change is not due to the food itself but to microbes which have entered the food in some way and changed it.

Some microbes are little animals and some are little plants. The microbe that causes malaria is classed as an animal, although you would never guess it from its looks. The yeast which makes our bread rise is a plant microbe. The molds which grow on preserves are plant microbes—very familiar to housekeepers. The most important of all

the microbes are those which belong to the group called **bacteria.**

Bacteria.—Although they are plant microbes, bacteria are very different from the plants we are accustomed to see. They are so small that 400,000,000 of them could be packed in a grain of granulated sugar. They are simple in shape

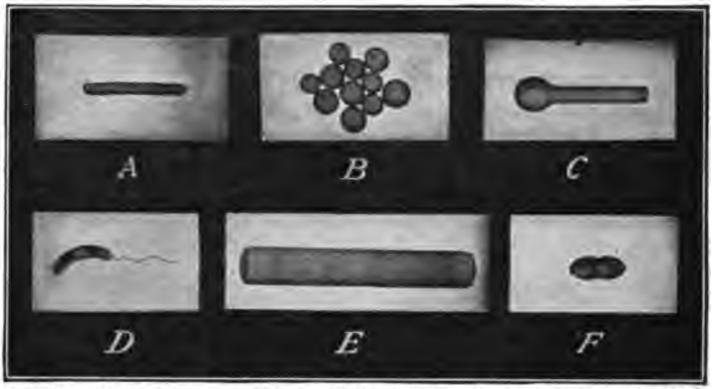

Fig. 84.—The forms of certain typical bacteria. From Models in the Hall of Public Health, American Museum of Natural History.

A. The bacillus of tuberculosis.
B. A coccus or spherical bacterium.
C. The bacillus of tetanus (showing spore).
D. The spirillum of cholera.
E. The bacillus of anthrax (a very large rod).
F. The coccus of pneumonia.

and look like tiny rods or dots, or minute sausages or cork-screws. Some of them have slender fins or flagella by which they swim about when they are in a liquid (for they are like animals in their power of movement), but they have no other parts at all, no stem, leaves, or fruit—no head, eyes, or stomach.

Bacteria grow very fast when they have plenty of food; and when one bacterium gets to a certain size, it simply

splits in half, and then there are two. This may happen again and again, every twenty minutes under favorable conditions. A little arithmetic will show that a very few bacteria in a glass of milk may increase to millions and millions within ten or twelve hours. Figure it out for yourself and see.

Fig. 85.—The germ of typhoid fever, showing the flagella by which it swims about.

Bacteria can live on many different kinds of food, but they must first change, or decompose, the food substance to a form which they can absorb. They bring about the changes in these substances by producing chemicals called **enzymes** or **ferments,** which are much like the enzymes formed by the digestive glands in your body.

How Bacteria are Studied.—The men and women who study bacteria are called **bacteriologists,** and in their laboratories they cultivate all sorts of bacteria, somewhat as plants are cultivated in a garden. All you would see in such a germ garden would be rows and rows of glass test tubes partly filled with liquid, or with slanting surfaces of jelly in them. On the top of the jelly, if you looked closely, you would see a grayish smear, or perhaps a whitish paste, or a brown wrinkled mass; this smear or paste or mass would be a growth made up of millions of bacteria. The bacteriologist, when he wishes to plant bacteria in a new tube, carries a tiny bit over from the growth on the point of a fine wire. By grow-

ing bacteria in different kinds of fluid, he can study their action on proteins, sugars, and other substances, and find out what they do and how the harmful ones can be killed and the useful ones cultivated.

The bacteriologist can determine, by a simple process, how many of these tiny plants there are in water or milk or any other substance. He mixes a measured amount of milk, for instance, with a melted jelly containing food which the microbes can use. Then he lets the jelly cool and harden

Fig. 86.—Some of the apparatus used by the bacteriologist in cultivating his germ garden.

in a covered glass dish, and keeps it at a temperature favorable for germ life. Each of the microbes imprisoned in the jelly begins to grow and multiply. After a day or two, little spots will appear, each spot being a colony of millions of microbes descended from the single germ planted there. By counting these colonies, we can determine how many germs there were in the milk that was mixed with the jelly.

Good and Bad Microbes.—Bacteria of some sort are found almost everywhere. There are a few floating in the air. There are some in almost all water, even the clear water we drink. There are more in dirty water, and untold

numbers in the tiniest speck of earth. There are millions and millions of them in your mouth and in your intestines, and many on your skin, hair, and every part of your body. If you could see the tip of your finger with a high-power microscope, you would find bacteria clinging there.

Many kinds of bacteria are useful rather than harmful to mankind. The flavor of butter is due to bacteria which

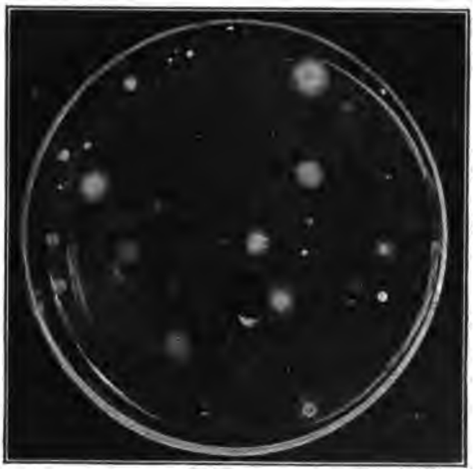

Fig. 87.—Colonies of microbes.

have grown in the cream from which the butter was made, and have formed pleasant-tasting compounds. Vinegar is made out of fruit juices by the action, first of yeast microbes, and then of vinegar bacteria. Bacteria destroy the dead bodies of plants and animals and other waste materials, which would make the woods and fields very unpleasant if they were not removed; and they change the waste materials into a form in which they can be used

as food by plants, thus helping to make the soil fertile.

Sometimes microbes decompose things we do not want changed, like the molds which grow in jelly, or the microbes which sour milk or spoil meat. We have to take great pains to prevent these microbes from growing, by keeping food cold, or by killing the germs by heat, as in canning and preserving.

Finally, there are several kinds of microbes which grow in the human body and cause disease. It is with these disease germs that we are particularly concerned just now.

How Microbes Cause Disease.—The particular kinds of microbes that cause disease are parasites; that is, they have the special power of growing in the body and at its expense. Some microbes may multiply in the nose and throat or in the intestines without doing any harm. The disease germs, however, form poisons called **toxins,** which are absorbed into the blood and cause the dull feeling, the headache, and other symptoms of sickness. Most disease germs do more than this. They find their way through the walls of the nose or alimentary canal, for instance, into the blood stream itself, and grow and multiply in the blood or in the organs of the body. Each kind of disease germ grows in certain special parts of the body, producing a particular kind of toxin and causing particular symptoms of disease, so that we can often tell by the kind of sickness which sort of microbe is at work.

At the place where the microbes are growing, there is almost always **inflammation,** or a reddening and heating of the part, due to the dilation of the fine blood vessels; and there is often local swelling and pain as well. Headache, fever, weakness, and disturbance of the bowels are common general symptoms of a bacterial invasion.

How the Body Fights the Microbes.—After the microbes have been at work for a while, and the body feels the effect of their poisons, one of the most wonderful of its powers, **vital resistance** begins to show itself. The body attempts to defend itself against the invading germs.

This fight against the microbes is carried on, in large part, by the colorless cells of the blood, the **white corpuscles,** to which reference was made in Chapter X. These white corpuscles are scavenger or soldier cells, which attack microbes in the blood, swallow them, and digest them by means of enzymes.

In the blood itself, too, special chemicals appear, which tend to kill the disease microbes and also to destroy the poisons they have formed. Throughout the course of the disease, this struggle is going on between the invading microbes and the body. If the patient gets well, it is because the microbes have been beaten.

After recovery, the blood for some time keeps the power of destroying that special kind of microbe and its poisons. This is why the person who has recovered from an attack of a communicable disease is **immune** from that particular disease for a longer or shorter time.

The Common Cold as a Type of Communicable Disease. The next time you have a cold in the head, think about these things you have learned, so that you may understand just what is going on.

There are three or four kinds of germs that cause colds. Whenever any one "catches cold," it is because some of these germs have entered his nose or throat and begun to grow there.

A cold often begins just after one has been chilled, or has had wet feet, or has become overtired. The healthy body

can defend itself against the germs of a cold, and such germs may be present in the nose or throat for a long time without causing any trouble. But after a chill, the body is weakened so that the microbes begin to grow and the real cold develops.

When the sneezing or coughing starts and the nose begins to run, it is because the germs are growing in the nose and throat and poisoning and irritating the delicate membranes. Some of the poisons have meanwhile been absorbed into the blood and are causing the sick feeling and the fever.

The best thing to do for a cold is to stay quietly in bed for a day. Rest helps the body to fight off the disease and destroy the poison of the germs. When one recovers from a cold, this process has been successfully accomplished, and for a little while afterward (only a little while in the case of the common cold—much longer in many diseases), the body is able to defend itself against germs of the same kind.

Too often, however, a person has meanwhile passed on the germs of his cold to other people, and by the time he has recovered they are going through the discomfort and danger—for danger may sometimes follow even from a common cold.

It is important that people should learn more about the way in which disease germs spread. They may then know how to avoid real dangers, and they may also save themselves from worrying needlessly about things that some people fear without good reason.

Questions for Discussion and Review

1. What is the difference between hygiene and sanitation?

2. What is a communicable disease? Name some common communicable diseases. Which have you had?

3. Describe some of the general symptoms of a communicable disease.

4. Who first discovered how communicable diseases pass from one person to another? How did the discovery happen to be made?

5. Do you know of any diseases which are carried from one plant to another or from one animal to another?

6. What is a microbe? What changes do microbes cause in different kinds of food?

7. What is a parasite? Give examples not in the text. Do we ever call people parasites nowadays?

8. What are bacteria? How do they grow? How fast do they multiply under favorable conditions? What do you mean by "favorable conditions"?

9. How do bacteria change food so that they can absorb it? Give examples of similar work done in our bodies in the process of normal digestion.

10. How do bacteriologists study the characteristics of different bacteria?

11. What work is done by some of the "good" microbes?

12. In what ways are all disease microbes alike? How do they differ?

13. What weapons do bacteria use in attacking the body? What is the defending army of the body? How does this army fight? How does it destroy its enemies?

14. Is the body always successful in its fight? How does the length of the fight vary?

15. What is meant by vital resistance? What effect do hygienic habits have upon it? What habits can you name which tend to lower vital resistance?

16. What is immunity? Does it always last through life?

17. One boy has a very slight cold. Another "catches" a cold from him. Is the second boy's cold sure to be as slight as the first, or may it develop into a more serious cold?

18. After thinking about the last question, do you believe

that for the sake of other people we are bound to avoid having colds, as far as possible? Explain.

19. A man said, "I was all run-down and I caught a cold." What did he mean?

20. A woman said, "When I am very tired and run-down, I do not dare to ride in crowded street cars." What did she mean?

21. What is the danger in leaving a soiled handkerchief about when you have a cold? What is the danger in sneezing, without putting a handkerchief to the mouth?

22. When one has a cold, why is it wise (1) to rest in bed, (2) to eat lightly of simple food, (3) to keep the intestines clear, (4) to have plenty of fresh air, (5) to drink plenty of fresh water, (6) to keep the body warm?

CHAPTER XX

HOW DISEASE GERMS ARE SPREAD

Where Disease Germs Come From.—The kinds of germs that cause disease do not come like wild animals from the forest or crawl out of the earth, nor are they created in decaying organic matter, as some people believe. To be afraid of the air that blows in through the windows, or of the good rich earth children dig in in the garden, is very foolish. Disease germs do not come from the great world of nature, but from people. They are microbes that have become especially fitted to live in the human body or in the bodies of some of the other higher animals. The body is the only place, as a rule, where they can grow and increase in numbers, because there only do they find the high temperature, rich food, and other conditions which they need. We may get disease germs into our bodies directly from water, milk, food, or some object; but we can always be sure that the germs came first from some other person or animal.

The germs of a particular disease must come, moreover, from a person or an animal already infected with that particular kind of microbe. Typhoid germs always come from other typhoid germs, diphtheria germs from other diphtheria germs, just as oak trees come from acorns. On the seacoast of Massachusetts there are acres and acres of pasture covered with a beautiful yellow flower called the broom plant. It is said to have spread from a few plants sent from England over a hundred years ago. So it is when some new disease, such as a plague or cholera, is introduced

into a country. It may spread like wildfire; but it can only spread as the broom did, by the living seed being carried from place to place.

Human Carriers of Disease.—It is not only people known to be sick who may spread the germs of disease. When a person is once in bed, he can be cared for, and the danger of distributing his germs is lessened. Many diseases, however, are most catching in the early stages, before any one realizes that anything serious is the matter. Measles, which is a dangerous disease and often fatal to young children, is most catching at the beginning, when the child who has it shows almost no signs of illness, except that he appears to have a cold in the head. Such a child may continue to go to school and mingle with other children, and may infect many of them with measles.

Fig. 88.—How milk bottles may be infected from the hands of a carrier.

In some cases, as in diphtheria and typhoid fever, the germs may continue living and growing in the bodies of people who have entirely recovered from the disease. Sometimes they even grow in the bodies of persons who have never had diphtheria or typhoid at all. Such persons are, for some reason, able to resist the germs, but may spread them to others who are not so fortunate. These well people in whose bodies disease germs are growing are called

carriers. An outbreak of over three hundred cases of typhoid in New York City was caused by a milkman, a typhoid carrier, who had had typhoid in Michigan forty-six years before and had been cultivating the germs in his body ever since.

There was a famous typhoid carrier known as "Typhoid Mary," who was found by the New York City Board of Health to have caused twenty-six cases of typhoid fever in different families where she had been employed as a cook. She was kept in restraint for a time by the Board of Health, and was then released, upon her promise not to act as a cook again. In 1914 a typhoid epidemic occurred in a hospital in New York City, and when it was investigated, Typhoid Mary was found to be the cause of it. She had broken her word, gone into the hospital as a cook, and had again infected food with her typhoid germs.

The studies of bacteriologists show that among people who seem to be quite well, two or three out of a hundred may be carriers of diphtheria germs, and two or three out of a thousand may be carriers of typhoid germs. The disease germs in some carriers are weak and not readily able to cause disease; in other cases they may be strong and vigorous.

What Happens to Disease Germs outside the Body.— Disease germs, as we have learned, are parasites especially suited for living in the bodies of human beings. In gaining this power, which the ordinary microbe does not have, they have lost the power of getting an honest living in the world outside. While most microbes grow and increase in numbers in dirty water, in the earth, or in decaying matter, disease germs die out in such places, for lack of the special foods and the other conditions which they need.

Fig. 89 shows how the number of typhoid germs decreases in a bottle of water which is allowed to stand quietly for several weeks. Much the same thing happens to all disease germs outside the body,—that is, they cease to multiply and

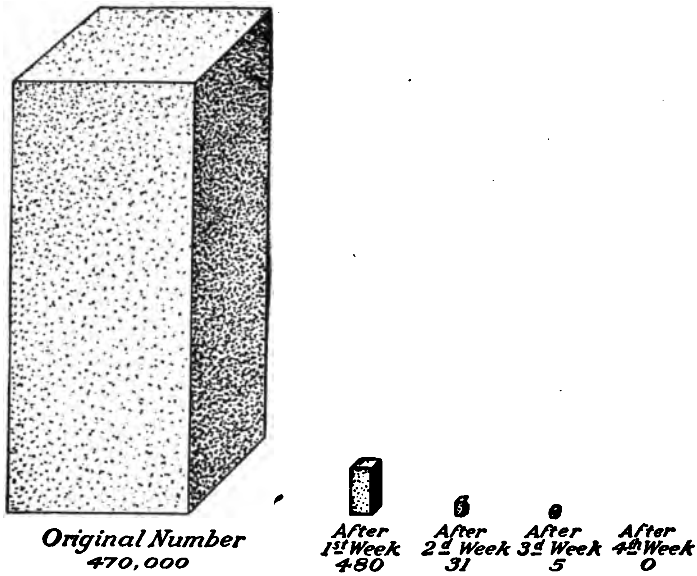

Fig. 89.—Diagram illustrating the rate of reduction of typhoid germs in water.

gradually die out,—although in milk disease germs may sometimes actually increase.

Germs do not die off *at once* outside the body. They may survive for a time in drinking water, on the fingers, on the edges of drinking cups, on towels, and on other things that have been soiled. Their numbers are always growing less, however (except in milk), and the stories of disease caused by toys or books put away for months or years are not generally believed to-day. The diseases supposed to be ob-

tained from such sources were probably caught from some unsuspected carrier in the street car or on the playground.

In order that communicable disease may spread, the germs, while still alive and active, must be carried quickly from one person to another. There are three principal ways in which disease germs are thus carried: by personal contact, by food and drink, and by insects. These three ways may be easily remembered by three catchwords, the three F's of sanitation: **Fingers, Food,** and **Flies.**

How Germs are Spread by Contact.—The most important of all the ways in which disease germs are spread, is by what we call contact. The catchword "Fingers" stands not only for the fingers themselves, but for all the ways in which germs may be spread by touching things. It is not necessary for people even to see each other in order to come in contact in this sense. The word *contact* is used to cover direct infection, such as occurs when one person coughs or sneezes into another's face, and also more roundabout transfer, such as occurs if germs on an infected towel are transferred to another person's hands and later to his mouth.

How Germs are Spread by Food.—The second important way in which disease germs are spread from person to person is by means of articles of food and drink. A supply of water or milk may carry disease germs to hundreds of people at once, all over a whole city. Some of the most dreadful epidemics have been caused in this way.

Foods which are eaten raw are most likely to be at fault. Thorough cooking destroys disease germs; and most cooked foods are dangerous only when they have become infected after cooking. Among raw foods, many are safe because

they are peeled before eating. Of all foods, the most dangerous are water and milk, because they are easily polluted, because they are drunk promptly before the disease germs have a chance to die out, and because they are usually not cooked.

How Germs are Spread by Insects.—The third common way in which disease germs are spread is by means of in-

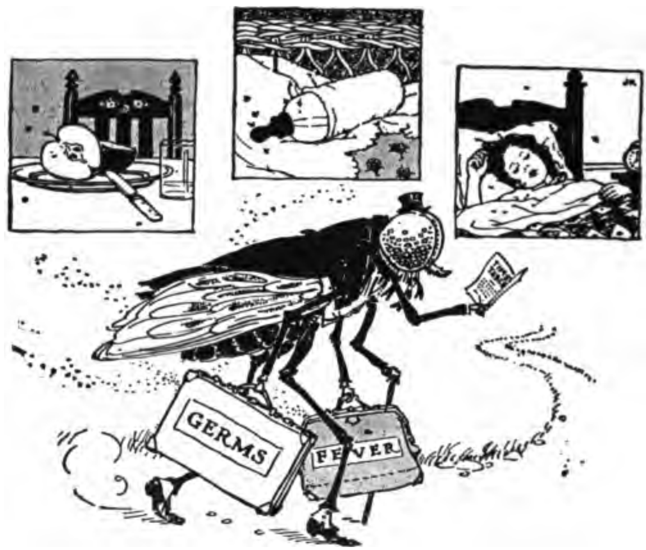

Fig. 90.—The fly on its travels.

sects. The catchword is "Flies," because flies are perhaps the most important insect carriers of disease in the United States. By picking up infected material on their legs and bodies and carrying it to food, they may distribute many microbes.

In warm countries, where there is a great deal of insect life, the danger of insect-borne disease is greatest; and in the

tropics such diseases as yellow fever, which is spread by the bite of a certain mosquito, are very prevalent.

Diseases Caught from Animals.—A few diseases may be caught from animals, although, as a rule, the germs that affect animals cannot attack human beings. It is an unclean habit, however, to kiss animals or to allow them to lick one's face, because of the dirt with which they may have been in contact. After fondling a cat or a dog, one should wash the hands with special care before eating.

The most serious disease which may be caught from animals is **rabies** (rā′ bĭ ēz), which is contracted from the bite of a dog suffering from this infection. He is called a "mad" dog because a dog with rabies rushes about, biting the people and animals he meets. Whenever there are cases of rabies in the vicinity, all dogs should be muzzled, so that they may not infect people or each other.

Questions for Discussion and Review

1. How do disease germs differ from the germs in decaying trees and leaves, and in the rich earth?

2. Where do disease germs come from?

3. In the preceding chapter, we spoke of the first epidemic of measles in the Faroe Islands. How must that epidemic have started?

4. What do we mean by a human carrier of disease? Is it necessary that a disease carrier should ever have had the disease himself?

5. The germ carrier, Typhoid Mary, could not help her unfortunate condition. Do you think that it was right, however, for her to continue to do a kind of work which endangered the lives of others?

6. Why do disease germs die after they have been outside

the body for some time? If they die in this way, how are diseases spread?

7. What are the three F's of sanitation? Explain "Fingers."

8. Suggest several ways in which germs may be spread by food.

9. Why should milk and water receive special care?

10. A man made the remark that the feeling against flies was growing to such an extent that the day was not far distant when flies in a house would be regarded as a disgrace to the household. What do you think about it? Was his opinion warranted?

11. Do you consider a kitchen full of flies *clean?* Is there danger in one fly?

12. Why does the Board of Health sometimes require that all dogs should be muzzled?

CHAPTER XXI

THE VALUE OF CLEANLINESS

Clean Dirt and Dirty Dirt.—Most of us think of anything that is soiled, stained, spotted, or in any way discolored, as *dirty;* and so of course it is, in a way. From a health standpoint, however, some kinds of dirt are much worse than others.

The worst kind of dirt is that which contains disease germs; and since such germs come from the human body, it is clear that anything which has been soiled with human excretions, or which has been in contact with the mouth or nose, is the kind of dirt that does most harm. A drinking glass that has just been used by another boy or girl may look bright and clean to the eye; but it is really dirtier than a boy's trousers green with grass stains. The green stains may be bad for the trousers, but they will not hurt the boy. On the other hand, if you looked at the rim of the glass with a microscope, you would probably see scales or particles from the lips of those who have used the glass, and many bacteria as well. Most of these bacteria would be harmless, but if, by any chance, the child who drank last were a diphtheria carrier, there might be diphtheria germs there and any one who used the glass without thorough cleansing would be likely to get diphtheria from it.

We must remember that different kinds of dirt are likely to go together. The child whose clothing and hands are usually dirty is not only unpleasant to look at but he is likely to catch any communicable disease that breaks out

in the school. There is a good chance that he may pick up disease germs along with the ordinary dirt he carries about with him.

Germs in Dust.—Some people are afraid of the dust that blows about in the air and always think that it contains disease germs. This danger is, however, not nearly so great as one might suppose at first.

It is true that dry dust contains a great many microbes, but most of them are harmless. The disease germs that are coughed, sneezed, or spit out into the street or on the floor, die out rather rapidly as they dry, particularly if they are exposed to air and sunlight. A few remain, of course; and if a wind stirs up a heavy cloud of dust in the street, a person may get a good deal of dust into the mouth and nose, taking in disease germs with it. This is particularly true in the case of the germs of tuberculosis, which are very widespread and are not so easily killed by drying as are other disease germs.

Care should therefore be taken, in sweeping, not to stir up any more dust than is necessary. For the same reason—and also because the moving of dust from one place to another is a foolish waste of time—dusting should be done with a soft cloth, not with a feather duster. The vacuum cleaner is the ideal instrument for cleaning, from this standpoint.

The fine dust which floats in the air of a quiet room, and which you can see as tiny glittering motes in a sunbeam, contains very few germs of any kind. In general, there is little danger of catching any disease from the air unless one is close to a person who is coughing or sneezing, or unless heavy dust is being stirred up by the wind or by careless sweeping indoors. Disease germs have no wings and cannot

fly across the room. They are spread, for the most part, not by the wind but by careless people who carry them about.

How Germs Pass from Mouth to Mouth.—When a person with some disease coughs or sneezes, a spray of fine drops is thrown out from the mouth. Each of these tiny drops may have thousands of microbes in it. If you wish to understand how diseases are spread, notice—the next time you have a cold in the head—how many chances the germs have of passing to some one else's mouth. Notice whether you put your handkerchief down and ask some one to hand it to you. Notice whether you cough in some one's face or over his hands or food. Notice how often you cough in your hand and then touch the water faucet or the door handle. If you watch, you will soon see the fingers that touched your handkerchief or the faucet or the door handle go into their owner's mouth, or touch something that goes into his mouth. There are thousands of such ways in which germs—and sometimes disease germs among them—pass from mouth to mouth.

Fig. 91.—How disease germs are spread by mouth spray.

The danger of spreading the germs of tuberculosis and other diseases is one of the principal reasons why well-mannered people never spit on the floor or on the street, and why health authorities make regulations prohibiting people from indulging in this filthy habit. The sputum of a consumptive may contain millions of tuberculosis germs; and

if discharged on the sidewalk, they may not only dry and blow about, but—a much more serious danger—while fresh and virulent, they may be carried on shoes, and from the shoes or from things the shoes have touched may easily get to the fingers and then to the mouth.

Guarding against Intestinal Diseases.—There are some diseases, like typhoid fever, in which the germs are spread,

Fig. 92.—These two girls are doing their sums with one pencil. Have they been well-trained in health habits?

not by way of the nose and mouth, but in the discharges of the alimentary canal and kidneys. The most common ways in which these microbes are spread is by polluted water or milk, or by flies. In the city, where there is a sewer system, the sewage is carried away at once in closed pipes, but in the country it is often hard to get rid of it in a sanitary manner. There is always danger that the drainage may pass through cracks in the ground and carry disease germs to the well, or that they may be distributed to food by flies.

Hookworm Disease and Its Control.—In the warmer parts of the United States a large number of people suffer from hookworm disease, chiefly as a result of the careless disposal of bodily excretions. The hookworm is a tiny whitish worm, a little less than half an inch long, which lives in the intestines and sucks blood from the wall of the alimentary canal. People affected with this disease grow pale, weak, and listless, often without knowing what is the matter with them.

The eggs of the hookworm pass out with the discharges from the intestines; and the young worms which hatch from them usually get into the body of a new victim by boring in through the skin of the foot, since in these warm regions many people go barefoot. The worm may also be taken in with dirty drinking water or dirty food.

People who have hookworm disease can be cured by special drugs which kill the worms in the alimentary canal. The most important step in preventing this disease, however, is to provide good toilet facilities, so that the soil will not be polluted with discharges containing hookworm eggs.

Guarding the Gateway of the Mouth.—Most of the common disease germs enter by way of the mouth. This is true not only of colds, influenza (or grippe), tuberculosis, tonsillitis, whooping cough, diphtheria, and the like, in which the throat and nose and lungs are the parts first affected, but also of such diseases as scarlet fever, measles, cerebrospinal meningitis, and probably infant paralysis. The first essential in avoiding communicable disease is to keep a guard over this gateway of the mouth and to see that the enemy does not enter there. You have perhaps read about the Trojan War and remember that when the Greeks wanted to get into the city of Troy they built a great wooden horse,

and hid some men in it, and left it on the plain outside the city walls. The Trojans were so curious that they brought the wooden horse into the city. At night the Greeks jumped out and opened the city gates to their comrades. That is the way with the disease germs. They hide on pencils, drinking glasses, and fingers, and we put them right into our own mouths.

I. *Nothing should ever go into the mouth except things to eat and drink—and the toothbrush. Nothing should ever go to the nose except a clean handkerchief.*

Fig. 93.—Washing the hands before eating is one of the first essentials of sanitation.

Since at mealtimes we must handle many things that are to go into the mouth, there is another rule of sanitation almost as important as the first one. The second rule is this:

II. *The hands should be thoroughly washed before meals and before eating any food handled with the fingers.*

Soap and hot water will destroy many germs, and a hard scrubbing will rub away any disease germs that are likely to come off on bread or cake. It should be pointed out here that the use of a common towel—a roller towel, for instance, that has been used by other people—may more than undo all the good accom-

plished by washing, and may pollute the hands with fresh and dangerous germs deposited there by the last user.

If the boys and girls who study this book really learn these two simple rules of sanitation, and follow them, the time they spend upon this study will be well worth while.

The Care of Cuts and Wounds.—As a rule, it does not matter much if we get dirt on the outer skin, provided it does not reach the mouth. The skin is too thick and firm for germs to find their way through it.

If there is a cut or a scratch, however, it is very different. The kinds of germs that cause diseases of wounds may get in through any break in the skin. They are very common in dirt and earth of all kinds and do not have to come fresh from sick people or carriers, as in the case of the communicable diseases.

A wound that has dirt in it is likely to get red and sore from the action of these germs, and sometimes the disease that follows is painful and dangerous. Any scratch or wound on the surface should be allowed to bleed freely and then washed out thoroughly with clean warm water. All wounds should be watched to be sure they are healing well. If they grow red and "angry," a physician should be consulted. In the case of a deep wound, a physician should always be called at once, for deep wounds are dangerous and cannot be safely dressed by any one else.

Questions for Discussion and Review

1. From a health standpoint, is a boy who has been digging in the garden or hoeing potatoes *dirty?*

2. People sometimes say in fun, "What's the use of washing? You get dirty again." Answer that question in earnest.

3. Do we get many disease germs from dust? Under what circumstances? What other danger is there from dust?

4. What is one great advantage of vacuum cleaners? If one does not possess a vacuum cleaner, what advantages may be gained by moistening the floor before sweeping?

5. Name some of the ways in which germs may be passed from mouth to mouth. What is meant by contact, in a sanitary sense?

6. Why is expectoration on the street or in other public places prohibited by law?

7. How is the hookworm disease passed from one person to another? Why is it more likely to be found in the poorer rural districts of the South than in cities?

8. Why is picking the nose a dangerous as well as an unpleasant habit? Criticize the habit of biting finger nails; sucking lead pencils; using a public drinking cup.

9. Why should one always wash the hands before eating?

10. Do you have your own towel in school? Do you have your own towel, washcloth, and toothbrush at home?

11. Why is it dangerous to allow dirt to get into a wound or a cut?

CHAPTER XXII

PURITY OF WATER AND FOOD SUPPLIES

Water Supplies and Health.—Of all foods, water has caused the most terrible epidemics of disease. In cities and towns where the water supply is carefully protected, this is no longer the case, but we still hear now and then of epidemics of typhoid fever due to polluted water in places where people are neglectful. The most dangerous source of supply

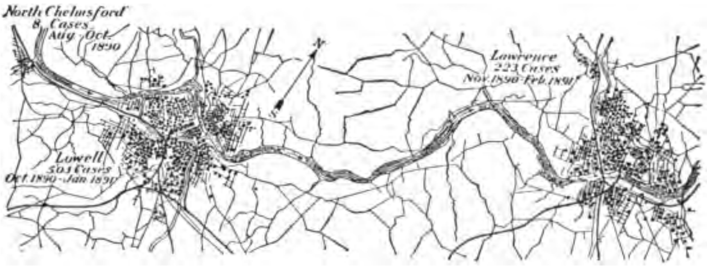

Fig. 94.—The epidemic of typhoid fever in the Merrimac River Valley in 1890–1891. Pollution was carried from the North Chelmsford cases to Lowell, and from the Lowell cases to Lawrence, farther down the river.

is a stream into which city sewers empty or into which pollution from outdoor closets may be washed in times of rain.

A famous example of water pollution of this kind was the epidemic of typhoid fever in the Merrimac River Valley in 1890–1891. At this time, the two large cities of Lowell and Lawrence in Massachusetts both used the water of the river for drinking, without any purification. In the fall of 1890 there were several cases of typhoid fever in the little village

of North Chelmsford, situated on a brook running into the Merrimac River a few miles above Lowell. Because of the careless disposal of sewage, the water in the brook became infected, and between October and January there were 503 cases of typhoid fever in Lowell. The sewage of Lowell was carried down the river to Lawrence, and between November and February there were 223 cases of typhoid fever in Lawrence. After this unfortunate event, both cities provided for purifying their water supplies, in order to prevent such occurrences in the future.

Purifying the Public Water Supply.—No surface water from lake or stream is safe for drinking, unless it has been purified in some way, because pollution may anywhere get on to the ground and be washed in by rain. Many cities that use river water purify it for drinking by the processes of filtration, in which the water is passed through great beds of sand which strain out harmful bacteria (as discussed further in Chapter XXVIII).

Protection of Well Water.—Just as river water may be made pure by passing it through a sand filter, so the water in an ordinary well is often purified by its passage through the soil, for if soil is of the right kind it will strain out bacteria, as the filter does.

Too often, however, a well is not protected at the top against surface drainage, and is really not a well at all but a little pond; and sometimes there are cracks in the soil through which pollution finds its way underground. The well should always have a curb rising above the surface of the ground, and a tight cover. It is important also that the upper eighteen inches of the well should be made tight against surface drainage. In order to avoid danger of pollution through the soil, the well should be at least fifty

feet away from the cesspool or outdoor closet or manure pile. It should not be on a lower level than these possible sources of pollution or between them and the nearest stream or pond, for the direction of flow of the underground water is generally toward the nearest body of surface water.

If there is any doubt as to the purity of drinking water, it should always be boiled. Boiling kills all disease germs and makes the most dangerous water safe to drink. Boiling drives out the air in the water and gives it a flat taste, but

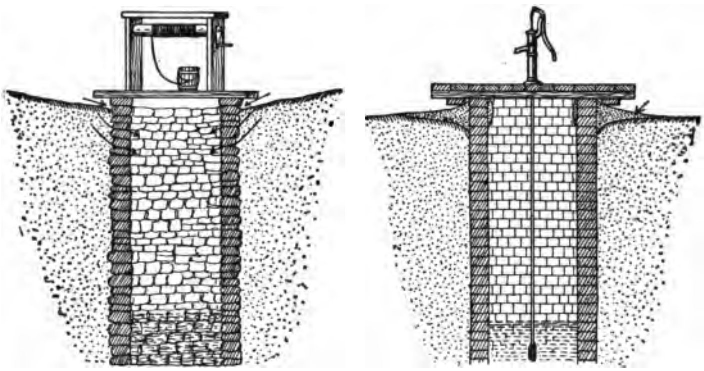

Fig. 95.—A bad farmyard well and a good one. Which is which?

the water will soon take in air again if it is allowed to stand in an open pitcher for a time or is poured back and forth from one pitcher to another.

The Individual Drinking Glass.—It is quite as important that water should be drunk out of a clean glass as that it should itself be unpolluted. Drinking from a glass previously used and soiled along the rim with germs from the lips is a common source of disease. This is the reason why many state and city laws forbid the use of common drinking cups. Every child in school should have his own individual glass, which should be kept in his desk and not left by the

sink for others to use. It is still better for the school to be provided with a good type of bubble fountain, so that no glass is necessary. If you want a drink where there is not a clean individual glass or a bubble fountain, it is easy to make a drinking cup out of a clean sheet of paper by folding it as shown in Fig. 96.

Ice.—Cold does not kill germs, as heat does, but it prevents them from growing. When ice forms on the surface

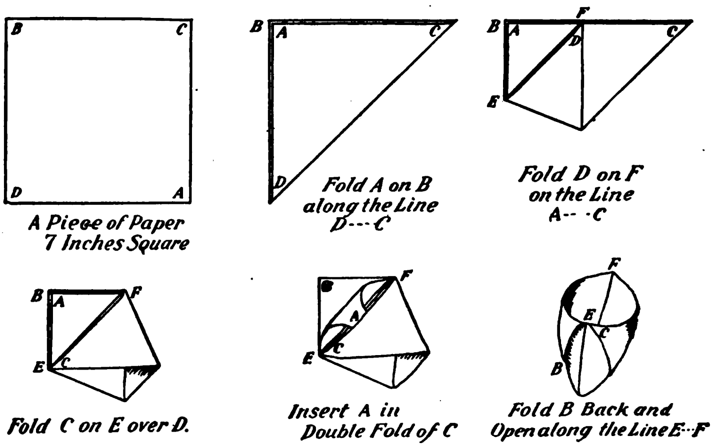

Fig. 96.—How to make a paper drinking cup.

of a pond, most of the germs are thrown out—in the act of freezing—into the water below the ice. Those that are left will almost all die out while the ice is being stored, since it generally stands for some time before being used.

The most important danger from ice is that it may be polluted by handling just before it is used. On this account, it is safer not to put ice into the drinking water. The best plan is to cool the water by placing it near the ice in the ice box.

Dangers from Milk.—In most well-governed cities, the public water supplies are now carefully guarded. Milk, however, is still one of the commonest sources of disease and probably causes more epidemics than water. If the greatest possible care is not taken, there are many chances for dirt to get into milk, from the body of the cow, from the stable, from the hands and clothes of the milker, from cans and bottles, and in the various steps of cooling and bottling. The ordinary germs from dirt do not die out in milk, as they tend to do in water, but multiply so rapidly that if the milk is not kept cold there are soon many millions in a thimbleful; and even the disease germs may multiply in milk at times. The souring of milk is the result of the activity of certain microbes growing in it. The dirt germs often affect milk so as to make it poisonous to young children; and the chief cause of sickness among babies in summer is dirty cow's milk.

In addition to the common dirt germs, the germs of tuberculosis may get into the milk from diseased cows, and germs of such diseases as typhoid fever, diphtheria, and sore throat may get in from sick people or disease carriers who handle the milk.

The history of city and state health departments is full of epidemics of typhoid fever, scarlet fever, diphtheria, and septic sore throat, caused by milk infected by a sick person or a carrier on a dairy farm. Fig. 97 tells the story of such an outbreak in a village on Long Island, New York. The daughter of a woman who owned a milk farm had a bad sore throat on April 16th, 1914. On May 9th the woman herself was taken ill, and on May 11th a man who did the milking and bottling became ill in turn. The germs of the disease got into the milk, and early in June septic sore

throat broke out among the customers of the dairy. Over two hundred cases of the disease occurred before the epidemic was ended.

How to Make Milk Safe.—In order that uncooked milk shall be safe, it must come from cows that are free from tuberculosis [1] or other disease; the barn and dairy buildings

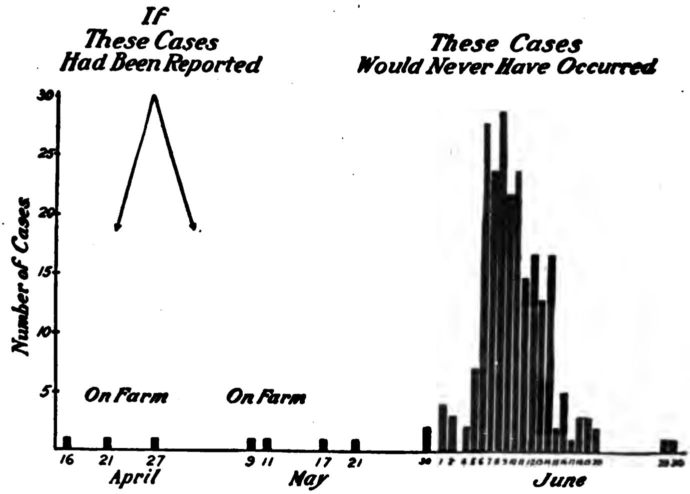

Fig. 97.—The story of the epidemic of septic sore throat on Long Island. The length of each vertical line shows the number of cases reported on a given day. (See scale of numbers on left.)

must be kept scrupulously clean; people who have sore throats or any other signs of disease must not milk the cows or handle the milk in any way; and the milk must be cooled at once and kept cool, to prevent the growth of germs.

It is very hard to be sure that all these things are attended to all the time. Fortunately there is another pre-

[1] It is possible to find out whether a cow has tuberculosis germs growing in its body by the use of a test called the **tuberculin test.**

caution that may be taken—milk may be **pasteurized,**—and this is the *only* way to make it really safe.

Pasteurization.—Pasteurized milk is milk which has been heated to a temperature of 145° Fahrenheit and kept at that temperature for thirty minutes. This process kills all the disease germs, and most of the other germs in milk, without making it indigestible. It is named for the great Frenchman, Pasteur, who first discovered that microbes cause disease.

On account of the great danger from raw milk, all milk for drinking, particularly for babies and young children, should be pasteurized. It is probable that some of the vitamins in milk are destroyed by heating, and when babies are fed only on pasteurized milk they should be given orange juice to make up for this deficiency.

In most cities it is easy to buy milk that is already properly pasteurized, but sometimes milk is sold as "pasteurized" which has been heated very hot for a few minutes or seconds only. This "flash" treatment, as it is called, is not pasteurization at all, and such milk is never safe.

How to Pasteurize Milk at Home.—Where properly pasteurized milk cannot be bought, the next best thing is to get good clean *bottled* milk and pasteurize it in the home. Never buy milk that is dipped out of a tank, for it is always dirty. It is almost as easy to pasteurize (or cook) milk as it is to cook any other food, and there is no more reason why we should drink uncooked milk than eat raw meat.

The best way to pasteurize milk is to set the bottles in a deep pan of water on the stove, put a milk thermometer into the water, heat up to about 145° or a little over, and then set the pan on the back of the stove, moving it back and forth now and then to keep the temperature, for half an

hour, as near 145° as possible, say between 140° and 145°. If you have no milk thermometer, it will do almost as well to heat the pan till the water boils, and then let it stand on the back of the stove for half an hour, although this may give the milk a slight cooked taste.

After the milk has been pasteurized, it should be cooled at

Fig. 98.—Pasteurizing milk in the home.

once. Though pasteurization kills all the disease germs, it does not kill all other germs, and those that are left will increase and will spoil the milk if it is not kept cool. The greatest care should be taken not to let milk stand in open dishes or in warm places, but to keep it covered and cold.

An interesting experiment may be made with four bottles

of fairly clean fresh milk. Pasteurize the milk in one bottle by heating it in a pan of water over an alcohol lamp in the classroom, or at home beforehand. Add some dirt to the milk in the second bottle. Then keep these two bottles and one of the others in a cold place, and the fourth bottle in a warm place. The bottles should be examined every day to see when each one curdles.

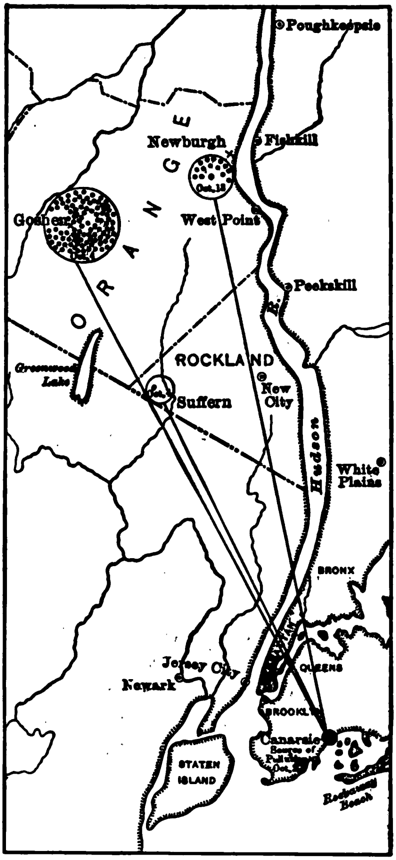

Fig. 99.—How typhoid and diarrhea were spread by oysters polluted in a creek at Canarsie, N. Y. Each black dot at Goshen, Newburgh, and Suffern represents a case of typhoid fever; each small circle, a case of diarrhea.

The Dangers in Uncooked Food.—Besides water and milk, there are other foods that are eaten raw, such as oysters, lettuce, and celery, which sometimes cause disease if they are not clean. Fig. 99 shows how oysters which had been polluted with sewage in a creek on Long Island, New York, carried typhoid fever to Goshen, Newburgh, and Suffern, three distant points in the state.

As a rule, cooking will destroy disease germs, but if the germs are in the inside of the food and the cooking is not thorough, they may survive. A disease called **trichinosis** (trĭk′ ĭ nō sĭs), caused not by a bacterium but by a parasitic worm which infects the hog, sometimes follows the eating of raw or partially cooked pork products.

Care of Food in the Store and Home.—Care should always be taken to protect foods from dust and flies, par-

Fig. 100.—Food on sale should be covered to protect it from flies and dirt.

ticularly cooked foods and those which are to be eaten raw. Flies may easily carry filth and disease germs to food, and it is important to keep the kitchen and the dining room screened and to buy only from stores which protect their food in the same way.

Food is also often polluted with disease germs by handling. The danger of such happenings would be much less if people with colds or other signs that they are "coming

down" with some disease would, so far as possible, keep away from the preparation and handling of food, and if every one who touches food would first wash his hands thoroughly.

Food Poisoning.—It sometimes happens that a number of people are made ill by eating meat, fish, or some other food that has become spoiled. Such attacks of food poisoning, also called ptomaine poisoning, are not caused by the common germs of decay. Indeed, some kinds of cheeses and other foods are generally eaten when they are decayed, without doing any harm. It is only when special kinds of germs are present that there is danger. Only a bacteriologist, after elaborate study, can tell whether these dangerous germs are present or not, and their presence cannot be detected by any special taste or odor. In order to be on the safe side, one should avoid all food, particularly meat or fish, that is spoiled or tainted to such an extent that it smells or tastes bad, or looks soft, slimy, or discolored, for such food is likely to contain the germs of food poisoning.

Meat that has been chopped up into small pieces, as in hashes or fricassees, is particularly likely to spoil on account of the amount of surface exposed to the germs of decay. All such dishes should be watched with special care.

Preservation of Food.—In order to avoid the danger of food poisoning, and to prevent the loss of good food by spoiling, it is important that all foodstuffs should be carefully guarded against decay. Since decay is caused by the growth of microbes, anything that will keep microbes from growing will keep foods from spoiling.

One way of doing this is by canning or preserving. In these processes the microbes already present in the food are killed by heat, and the can or jar is then sealed so that no

more microbes can get in. Tinned foods should be removed from the cans as soon as they are opened, for food standing in the open tin may absorb poisonous substances dissolved from the can by bacterial action.

Cold is another excellent preservative. It does not kill the germs, as high heat does, but it checks their growth; and in cold storage warehouses where food is kept at freezing temperature or below, it will keep sweet and good for months or years. Food preserved in this way spoils quickly when it is taken out, and should be handled with care and used promptly. We cannot, of course, get temperatures as low as freezing in the home, but the ice chest is cool enough to check the growth of germs and helps greatly in keeping food fresh.

Another way of preserving foods is by the use of chemicals which stop the growth of germs. Sugar, salt, and vinegar are used in the household for this purpose; and other chemicals, like sodium benzoate, are used by manufacturers. Some of these commercial preservatives may be poisonous when they are used in too large amounts.

Keeping food clean always helps greatly in preserving it. If food is exposed to dust or to crawling insects, or if it is kept in dirty dishes or handled with dirty hands, it is likely to spoil. Special pains should be taken to keep the ice chest clean and free from odors, which are readily absorbed by many foods.

Questions for Discussion and Review

1. Why is it not safe to drink the surface water of a lake or stream?

2. Why is the water in wells not always pure? What measures should be taken to protect it?

3. Where does the water supply of your school come from?

Your home? What measures are taken to insure the purity of this water?

4. Is lake water more dangerous before or after a heavy rain? Why?

5. By what simple method may any drinking water be made safe, in the home?

6. Have you your own drinking cup at school? Learn how to make one of paper, preferably paper with a glazed finish so that the water will not soak in easily.

7. Did you ever use a bubble fountain? What is its advantage? How high should the water in the fountain rise above the metal base?

8. Does freezing kill disease germs? Why do they die when stored in ice for some time?

9. Why do germs grow faster in milk than in water? Compare the chances of disease germs getting into water and into milk.

10. What causes milk to sour? Will it sour if there are no disease germs in it?

11. What steps should be taken to keep milk clean and relatively free from germs? Have you ever seen a model dairy? What measures are taken in such a dairy to make everything sanitary?

12. What is pasteurization? What does this process do to milk?

13. What could you learn in the experiment with the four bottles of milk (page 255)?

14. What are vitamins? Find out what vitamins do in the body and what conditions arise when they are not present. (Part One, pages 76-81.)

15. There are dangers in uncooked foods. Does that mean that we should eat only cooked foods?

16. Does cooking always destroy germs and their toxins?

17. What is the cause of so-called ptomaine poisoning?

18. A government meat inspector found in a butcher shop

some beef which was dark and slimy and had an unpleasant odor. The proprietor insisted that he did not intend to sell the meat to his customers. It was to go into a consignment to a sausage factory. What do you think of his defense?

19. What causes the spoiling of foods? Describe some ways of preventing or postponing such spoiling.

20. What do we mean by cold storage? What can you say for and against it?

21. When manufacturers' bottled or boxed foods are marked "Guaranteed under the Food and Drugs Act, June 30th, 1906," what does it mean? (See page 84, Chap. VII.) Does it mean that foods so marked are guaranteed as good to eat?

22. A housekeeper said, "If my kitchen and bathroom are clean, I never worry about the rest of the house." Explain.

23. Write to the Board of Health of New York City (or any large city near you) for the Sanitary Code. Find out what the city demands for the care and protection of food from dirt and infection.

CHAPTER XXIII

FIGHTING OUR INSECT ENEMIES

Insect Carriers of Disease.—The third important way in which germs are carried from person to person is by means of flies, mosquitoes, and other insects.

The germs of some diseases may be carried by insects occasionally and accidentally, as in the case of the ordinary fly, which picks up infected matter on his feet and carries it to food. There are other diseases, like malaria and yellow fever, in which the germ actually grows and multiplies in the body of the insect. Most diseases of this last kind are spread by the bite of one particular insect and in no other way.

Plagues of Olden Times.—In olden times when our great-great-great-grandfathers lived in conditions of filth that no one would think of enduring to-day, there were a great many more insect pests than there are at present. Perhaps the most terrible of all human diseases was the bubonic plague or Black Death, which swept over Europe in the fourteenth century and killed a quarter of the whole population. We now know that this is a disease of rats; the germ is carried from one rat to another, and finally from rats to men by the bites of fleas.

In 1894 there was an outbreak of bubonic plague in Asia, and since then the infection has been spread along the great highways of commerce all over the world, by the ships passing from one seaport to another. We have had single cases in San Francisco and New Orleans, and there have

been others at various points from England to Australia and from China to Brazil. Yet nowhere outside of Asia has the disease made any headway, because at every seaport where it has appeared there has been a vigorous campaign against rats, which has stamped out the infection. At some seaports it was found that the rats passed to and from ships

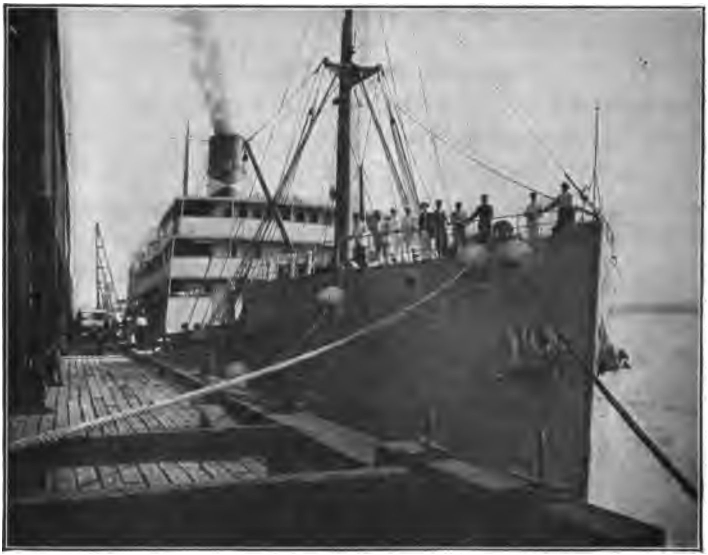

Fig. 101.—A ship from a plague-infected port; the ropes are equipped with guards to prevent rats from getting ashore.

along the mooring hawsers, and this has been prevented by slipping wide collars along the hawsers, which block the progress of the rats.

Another terrible disease of olden times was typhus fever, sometimes called ship fever, or jail or camp fever, because it was so common under the unsanitary conditions of ships, jails, and army camps. The germ of this disease is carried

from one person to another by the bite of the louse. With the better habits of personal cleanliness which prevail to-day, this disease had almost disappeared from civilized countries; but in 1915 the filthy conditions along the south-eastern battle front of the European war gave it a new chance to spread.

Fig. 102.—Armed against typhus fever. An orderly in a French Military Hospital, dressed in a suit closed tightly at wrists and neck, to exclude lice.

The Filthy Fly.—There are many different kinds of flies, but the commonest kind about our houses is the one which, on that account, is generally called the house fly. It ought not to be a *house* fly, and we intend that it shall soon cease to be a *house* fly. It always is and always will be a *filth* fly, however, for it breeds in filth, lives largely on filth, and carries filth wherever it goes.

The fly, like many other insects, goes through four stages in its life history. The mother fly lays her tiny white eggs in manure, garbage, or other refuse or decaying organic matter. From each egg hatches out a little white maggot or larva (lär′vȧ) which grows for four or five days. It then burrows down into the ground and changes to a motionless resting stage, called the pupa, like the chrysalis of a butterfly or moth. After four or five days more, the adult fly comes out of the pupa and makes its way up to the air.

Fig. 103.—The house fly, or filth fly. From the Model in the Hall of Public Health, American Museum of Natural History.

As the fly passes from the places where it breeds to our houses, and possibly to the dinner table, it carries all sorts of filth germs on its feet and body, and among them there may be disease germs too. If you let a fly walk over a bacterial culture plate,—a shallow dish containing a jelly on which germs can grow,—its path will be marked by colonies of bacteria which it has planted there. The dirtier the surroundings, the greater is likely to be the number of microbes carried by the fly. A bacteriologist collected some flies and washed off the germs on their bodies by shaking them in water. The average number of microbes per fly was over one million for flies from dirty places and only fourteen thousand for flies caught in clean places.

Fig. 104.—The foot of the fly, showing the relative size of typhoid germs which it may carry.

In the Spanish-American War, about one out of every five of our volunteer soldiers had typhoid fever, and it was found that the fly was one of the principal agents in spread-

ing the disease. In Jacksonville, Florida, flies used to cause a great deal of typhoid, until a campaign for the screening of outside closets reduced the typhoid death rate of the city to less than one fourth of what it had been.

Typhoid fever is by no means the only disease that is carried by flies. Studies made by the Association for Im-

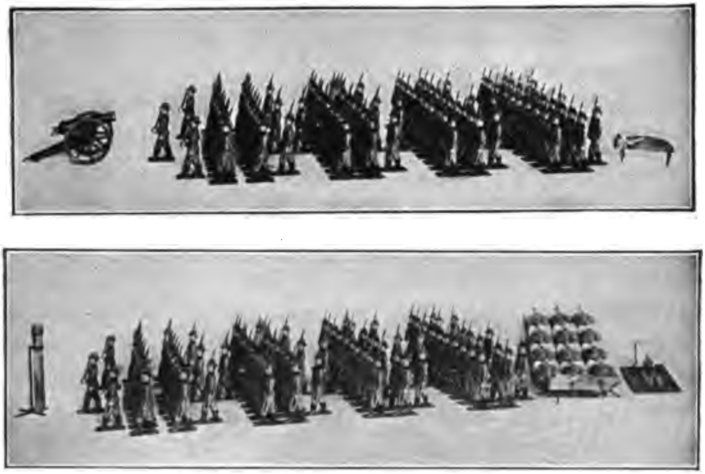

Fig. 105.—Relative deadliness of battle and disease in the Spanish-American War of 1898. (Above) One man out of 100 wounded in action. (Below) Thirteen out of 100 ill with typhoid and one dead. From the model in the Hall of Public Health, American Museum of Natural History.

proving the Condition of the Poor in New York City showed that babies which were carefully protected from flies had only one half as much diarrheal disease (summer complaint) as babies not protected in this way.

How to Fight against the Fly.—Flies are not only a nuisance, therefore, but a real danger to health.

There are four principal ways by which we may fight

against them: by preventing their breeding, by trapping them, and by keeping them away from human discharges and from food. Anti-fly campaigns are becoming very popular in many places, and justly so. These campaigns, however, might sometimes be conducted so as to do much more good than they now accomplish. "Swatting" flies often has a prominent place in them, but "swatting" is a much less effective method than preventing the breeding of flies and trapping them.

Destroying the Fly's Breeding Places.—The first and most important thing to do in getting rid of flies is to prevent their breeding by taking care of the materials in which the maggots can grow. As manure is the fly's favorite breeding place, great pains should be taken, wherever there is a stable, to keep the manure in tight, dark, covered bins and to disinfect it with borax or hellebore to destroy the maggots. Another good way to keep manure is in a box with a perforated bottom, having a pan of water underneath. If the manure is kept moist, the maggots when full grown will go down in search of the earth, and crawling through the holes in the bottom will drop into the water, where they drown.

Manure is not the only breeding place of the fly; all sorts of decaying rubbish must be cleaned out from the yard and street, if the number of flies is to be reduced. The removal of such fly-breeding rubbish is one of the most important factors in an anti-fly or general "clean-up" campaign.

Trapping Flies.—Trapping the adult flies is also an important measure of control. The traps which are most effective consist of wire cones opening upward into wire cages. Some bait that will attract flies is placed under the lower wide opening of the cone, and the flies on leaving the

bait will fly upward through the small end of the cone into the cage.

A description of a good fly trap and of the way in which any one can easily make such a trap is given at the end of this book (page 386).

Other Protections against Flies.—Cleaning up and trapping greatly reduce the number of flies, particularly if begun early in the season; but these measures will not destroy them entirely. It is important to prevent the remaining flies from carrying disease germs, by keeping them away from human discharges where they pick up such germs, and from food where they may deposit them. Outside closets should be made tight and screened against flies, and the doors and windows of houses should be screened, especially in the kitchen and the dining room and in any room in which there is a case of sickness. Care should be taken to see that screens fit closely and that they are always in place, and that screen doors are not left ajar or held open. If wire screens cannot be provided, flies may be kept out by cotton mosquito netting tacked over the windows.

Mosquitoes and Malaria.—The name *malaria* means bad air, and not very many years ago it was thought that this disease was caused by some strange gas that rose from marshes or from places where the earth had been dug up. It was finally discovered that the cause of malaria is a germ which grows in the blood. This germ cannot get out of the body and be carried from one person to another in any direct way, but only by the bite of a mosquito which has drawn the germ up through its sucking tube along with the blood it feeds upon. This discovery cleared up at last the mysterious connection between malaria and marshes and upturned soil. Mosquitoes breed in stagnant or slowly running water,

and the reason why ditches and swamps favor malaria is that they furnish the water in which mosquitoes breed.

Curiously enough, there is only one kind of mosquito (the A noph′ e les mosquito) in whose body the malarial germs will live long enough to be carried from one person to another. Mosquitoes, like flies, go through four distinct stages of growth, and in the second and fourth of these

Fig. 106.—A typical mosquito-breeding marshland.

stages it is easy for any boy or girl to tell the malarial mosquito from the common kinds. (See Figs. 107 and 108.)

From the eggs laid by a mosquito on the surface of a pool or sluggish stream, there hatches out a little larva or wiggler, so called because it jerks about in the water in which it lives and grows. If there are mosquitoes about your house or school, a little observation will soon show you where they are breeding. The little blackish wigglers, about three eighths of an inch long, are generally collected at the surface. When they are quiet, the wigglers of the com-

mon mosquito (Culex) rest at an angle with the surface, and those of the malarial mosquito (Anopheles) rest flat against it. If you dip up some water from a pool or stream in a white cup and find little wigglers like the picture, you may be sure that mosquitoes are breeding there. After a week or so the larvæ change to curiously shaped pupæ, and in a few days more these pupæ hatch out into adult mosquitoes, which emerge from the pupa cases floating

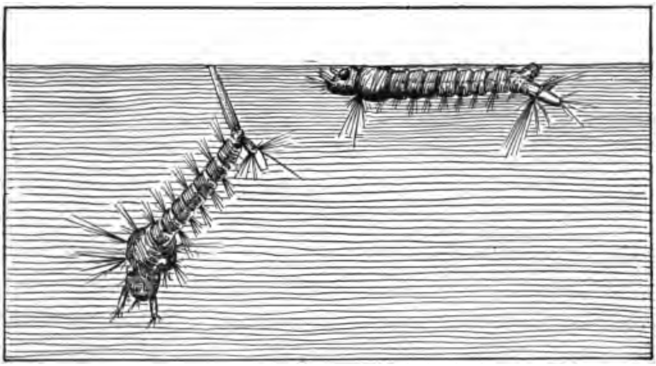

Fig. 107.—Resting position of the larvæ of the common mosquito, Culex (left), and the malarial mosquito, Anopheles (right).

on the surface of the water and, after strengthening their wings for a few moments, fly away.

The common mosquito, when full grown, rests in a sort of humpbacked position more or less parallel with the wall on which it is standing, while the malarial mosquito stands out from the wall in a nearly straight line (see Fig. 108). You can also tell the malarial mosquito by the fact that it has spotted wings.

How to Control Mosquitoes.—The way to control the breeding of mosquitoes is to drain or fill in small pools, clear the channels of sluggish, weedy streams, and empty barrels,

pails, tin cans, and everything else containing stagnant water in which the insects may breed. If a pool cannot be got rid of, mosquito breeding can be prevented by pouring a little kerosene or crude oil on the water every two weeks. The oil spreads out in a thin layer on the surface and kills the larval mosquitoes because the wigglers must come up to the surface to breathe, and if the surface is covered with oil they cannot get their breathing tubes through it to reach the air.

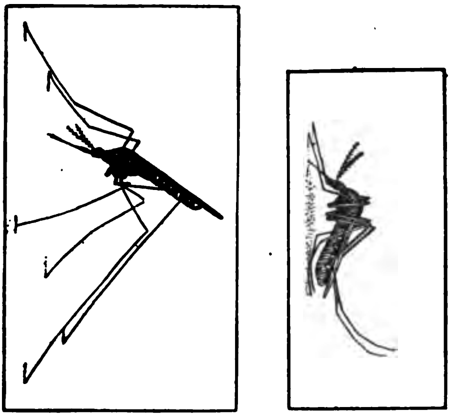

Fig. 108.—Resting position of common mosquito, Culex (right) and malarial mosquito, Anopheles (left).

Fish, frogs, and some of the larger water insects eat a good many mosquito wigglers. A pool that is too pretty to be drained or oiled is often stocked with fish to prevent mosquitoes from breeding.

Houses in malarial regions should be carefully screened, and beds protected by netting. Particular care should be taken to avoid letting Anopheles mosquitoes bite malarial patients and thus acquire the infection which they may carry to others.

School Sanitary Squads.—In many schools, Health Leagues or Sanitary Squads have been organized to work under the direction of one of the teachers, the school physician, or the school nurse. Their task is to study and im-

prove the sanitary condition of the school building and grounds.

Such a Sanitary Squad can do real service by inspecting the surroundings of the school to see where insect pests are breeding. They can soon learn to recognize fly maggots and mosquito wigglers, both the common and the malarial kind. Once the breeding places are found, it is generally easy, by cleaning up or oiling, or by some of the other ways described above, to get rid of most of these dangerous pests.

The Health Leagues should meet at regular intervals for talks by teachers, health officers, or public-spirited physicians, in regard to the sanitary problems of the school and the community. They may select their own officers and provide for and appoint, with the approval of the teacher, committees on heating and ventilation, water supply, toilet facilities, school grounds, flies, and mosquitoes.

The war against insect pests requires keenness, patience, ingenuity, and real scouting work to find the enemy. It is civic service of the right sort, for every campaign against these pests is a part of the great defensive war of humanity against disease.

Committees of the Health League.—A Committee on Heating and Ventilation should be formed, including a health officer in each classroom. His work is to read the thermometer at regular hours each day for a certain period and chart the readings on a blackboard space reserved for the purpose, where pupils, principal, janitor, and visitors can see a week's record at a glance. It is the duty of this committee, when conditions permit, to readjust heat sources, ventilators, or windows to secure proper temperature, which, when artificial heat is used, should never exceed 68° Fahrenheit. Older

boys may make observations of humidity, dust, and air currents.[1]

A Committee on Water Supply should study the source of water supply in use by the school or the community, in the light of instruction given at one of the meetings of the League; and should be charged particularly with the duty of observing and guarding against the use of common drinking cups.

A Committee on Toilet Facilities is charged with supervision of the cleanliness of toilet apartments. Washing facilities and the danger of the common towel fall within the scope of this committee's work.

A Committee on School Grounds is responsible for the general neatness of the school yard and surroundings.

It is the duty of a Committee on Fly Prevention to make a careful study of neighboring rubbish heaps in order to find out where the maggots are breeding. Boys who are clever at carpentry can build fly traps for the school yard and schoolrooms.

A Committee on Mosquito Control undertakes to locate the breeding places of mosquitoes; and the older boys may perhaps be intrusted with the periodic oiling of the breeding pools.

The Conquest of Tropical Disease.—In warm countries there are a great many insect-borne diseases, and their control since the beginning of the twentieth century is the most brilliant chapter in the history of public health. One of the first and most important steps in this great task, the discovery of the transmission of yellow fever by the

[1] The work of such a committee in regard to heating and ventilation is described in the Report of the Committee on Janitor Service of the National Education Association, July, 1913.

mosquito, was made by four American army surgeons. The story is such a splendid one that all American children should know it.

These four men, Doctors Reed, Carroll, Lazear, and Agramonte, were sent to Cuba in 1900 to study yellow fever,

Fig. 109.—Major Walter Reed (1851–1902), leader of the band of gallant American army surgeons who discovered the secret of yellow fever.

which had been killing seven hundred and fifty people a year in the city of Havana and was spreading among our soldiers. The investigators suspected a certain mosquito as a possible cause. They could not experiment with animals, because only human beings have yellow fever. So they tested their theory by allowing themselves to be

bitten by mosquitoes which had bitten yellow fever patients. Carroll was the first to be successfully infected with the disease in this way. He came down with yellow fever and was very ill, but finally recovered. Lazear was the next to come down, and he died. Yet the experiments went on, and there was never lack of volunteers from the army to take this terrible risk.

Besides the physicians, the first volunteers to offer themselves were two men in the government service, one a soldier and the other a civilian,—Kissinger and Moran. The only stipulation they made was that they should receive no pay, since they were performing this service for the sake of humanity. Major Reed, when they made this offer, touched his cap and said, "Gentlemen, I salute you."

Both Kissinger and Moran were exposed to the bites of infected mosquitoes and came down with the disease. Kissinger was the first of the non-medical volunteers to be experimented on. Of him Dr. Reed wrote, "In my opinion this exhibition of moral courage has never been surpassed in the annals of the army of the United States." Both of these men recovered, but Kissinger ten years later was awarded a pension from Congress for hopeless physical disabilities resulting from the experiments.

By March, 1901, this gallant band of investigators was able to announce that yellow fever was spread by the bite of a certain mosquito, and in no other way. At once an active campaign was begun against this particular insect, and the result was that there were only eighteen deaths from yellow fever in Havana that year, and none at all in 1902. The terrible disease which had cursed the city for half a century was wiped out in a single year.

Heroes of Science.—The history of medicine and public health is full of examples of quiet, unnoticed heroism, such as that which occurred at Havana. Howard T. Ricketts of Chicago was a brilliant young American investigator who gave his life in the fight against insect-borne disease. He died of typhus while studying its control in Mexico. Fif-

Fig. 110.—The Panama Canal, a triumph of American sanitation.

teen or more members of the United States Public Health Service have lost their lives in the course of their studies and as a result of them.

The Building of the Panama Canal.—It was the discovery made by Major Reed and his associates, with other discoveries in regard to insect-borne diseases, that made possible the building of the Panama Canal. The Isthmus of Panama was one of the most notorious plague spots in the world, and it was disease rather than engineering difficulties

that drove the French back when they attempted to build a canal across it.

When the United States began its work, Colonel W. C. Gorgas, fresh from the fight against yellow fever at Havana, was placed in charge of the sanitary part of the under-

Fig. 111.—William C. Gorgas (1854–1920), conqueror of yellow fever on the Isthmus of Panama.

taking. He began a campaign against mosquitoes similar to that which had been so successful in Cuba. He had to overcome the opposition of those who looked upon the mosquito theory as an impractical one, but his success was immediate as soon as he was allowed to deal with the yellow fever problem in the way which the Havana experiments

had indicated. So successfully did his sanitary army ditch, drain, and oil, remove mosquito breeding places, and destroy adult mosquitoes, that yellow fever has been abolished on the Isthmus, and malaria reduced to a low figure. The completed Canal stands as a triumph of American engineering, and as an even greater triumph of American public health science.

Questions for Discussion and Review

1. Compare the history of plagues in the fourteenth and in the nineteenth centuries. What was the difference?

2. How is the bubonic plague carried? By what measures may it be controlled?

3. What conditions existed in 1915, on the southeastern battle front in Serbia, which would cause such a disease as typhus fever to spread?

4. What are the different life stages of a fly? When is the best time in the life of a fly to destroy it?

5. What diseases are frequently carried by flies?

6. In what different ways can we fight the fly?

7. Jenny left her baby brother's carriage standing for a long time outside a badly kept stable. Was this dangerous? Why?

8. How should manure be kept? How may fly maggots be killed?

9. Explain the working of a trap like the one described in the Appendix (page 386). Make one like it, if you can.

10. Compare the life stages of the mosquito with the life stages of the fly.

11. Why did people think that malaria came from swamp gas? How is malaria carried from one person to another? What connection has this with marshy land?

12. How do mosquitoes breed? Where are the eggs laid? How may the eggs and wigglers be destroyed?

13. John found an old rain barrel swarming with mosquito

wigglers. There were none in a goldfish pond near by. What is the probable explanation?

14. How could you organize a Sanitary Squad or Health League in your school? What work could you find for this League to do?

15. What health conditions were found in Cuba when our soldiers went there during the Spanish-American War? What was done to remedy these conditions?

16. Which do you think requires the finer courage: going into battle, or offering yourself for such a scientific research experiment as is described on page 274? Which is of greater service to the world?

17. Tell the story of the Sanitary Campaign in Panama. Even if our engineers had been no more skillful than the French engineers, why would we have succeeded in building the canal when they failed?

CHAPTER XXIV

ISOLATING CASES OF DISEASE

Importance of Isolating Infected People.—Since disease germs come originally from infected people, it is clear that one of the best ways of stopping the spread of disease is to find these people and see that they do not pass their germs on to others. In the case of carriers who are perfectly well, we cannot do this, because we usually do not know who they are until an epidemic occurs.

When we do know, however, that a person has some communicable disease, everything should be done to see that the infected person is separated from others, so that disease germs shall not spread farther. This practice is called **isolation.**

What Isolation Means.—Until recent years, before it was known just how disease germs spread, not only the sick person but the whole family were often shut off from the rest of the world. This is called **quarantine.** Sometimes quarantine was declared against a whole country where some terrible disease was known to exist; that is, a government would decree that no one from the country where disease was raging should enter its borders. Old-fashioned quarantine was very inconvenient, and it is seldom necessary to-day to take such harsh measures. The modern way, when ships come from countries where there is plague or cholera, is not to quarantine the whole ship's company but to detect the few infected individuals by bacteriological tests, isolate them, and let the rest depart.

Isolation means simply the taking of proper precautions to prevent disease from spreading, inside the family or out. In order that this may be done, the law requires that all cases of communicable disease shall be promptly reported

Fig. 112.—Bedside care of a case of communicable disease.

to the health authorities, so that the health officer may arrange for the necessary care.

The person who is suffering from the communicable disease must be in a separate room, away from the rest of the family. The nurse, mother, or other person in charge must take the greatest care that nothing soiled by the discharges of the patient leaves the room without first being **disinfected**—treated in such a way that the disease germs will be destroyed. All discharges from the nose, mouth, and ears of the sick person should be received on clean cloths which

can be burned or disinfected with chemicals. Handkerchiefs, bedding, forks, spoons, dishes, and anything else which may have been infected by the patient should be boiled or otherwise disinfected. No one, except the doctor and the person caring for the patient, should come into the room. The nurse or attendant must see to it that she does not carry germs out of the room on her fingers or clothing. She should *always* wash or disinfect her hands before leaving the room, and it is a good plan for her to have a special gown for the sick room, which she changes when she goes out.

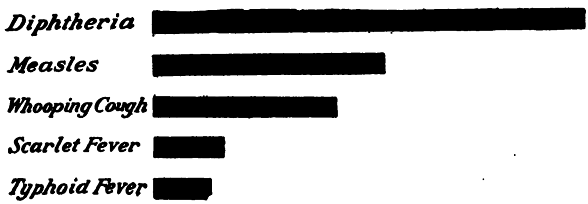

Fig. 113.—The relative importance of certain common communicable diseases as causes of death in New York City.

Whenever there is a case of communicable disease in a house, a placard should be posted outside to warn people not to enter. If the patient is properly isolated, however, the members of the family who do not come in contact with him need not be a danger to others; if they are immune from the disease (by reason of an earlier attack), they may in many cases go freely about their business. People who have once had chicken pox, German measles, measles, mumps, or whooping cough are generally immune from these diseases.

If, on the other hand, the house is crowded or for any other reason isolation cannot be carried out there, the sick person should be taken to an Isolation Hospital, where he can be properly cared for.

The Communicable Diseases That must be Isolated.—The Board of Health in each city, and in many states, has special rules as to just what diseases are to be isolated and how the isolation is to be carried on. There are thirteen diseases which are so common and so important that special precautions are taken in regard to them almost everywhere. These are chicken pox, diphtheria, German measles, infant paralysis, influenza, measles, mumps, scarlet fever, septic sore throat, smallpox, tuberculosis, typhoid fever, and whooping cough.

In almost all these diseases, the germs are spread in the fine spray thrown out from the mouth in coughing or sneezing, and in the other discharges from the nose, mouth, and sometimes the ears.

Every one knows that diphtheria, scarlet fever, smallpox, and typhoid fever are serious, but many people think that measles and whooping cough are merely "children's diseases" and are not of much consequence. This is a great mistake, for in many cities more people die of measles than of typhoid fever, and more die of whooping cough than of scarlet fever. These diseases are particularly deadly for young children, and the greatest care should be taken to protect them from infection.

How Long Isolation should Continue.—Each communicable disease has its own definite period of duration, and experience teaches that a certain number of days or weeks must pass before it is safe for the patient to mingle with other people. The periods of isolation for the more common communicable diseases of children are shown in the following table. In each case, of course, the patient should be isolated until he has entirely recovered from the disease, and running of the nose or ears has ceased. In diphtheria,

the only safe rule is to wait until tests made by a bacteriologist show that the nose and throat are free from diphtheria germs.

ISOLATION PERIOD OF COMMON COMMUNICABLE DISEASES OF CHILDREN

Disease	*Isolation Period from Time of Beginning of Attack*
Chicken pox	12 days
German measles	8 days
Measles	10 days
Mumps	2 weeks
Scarlet fever	30 days
Whooping cough	8 weeks, or until one week after the last whoop

Disinfection and Cleansing.—After a person has recovered from an attack of a communicable disease, the health authorities sometimes order that the room in which he has been ill shall be disinfected or fumigated. **Disinfection** is the treating of anything with chemicals, or heat, or in other ways, for the purpose of destroying disease germs. **Sterilization** is the destruction of all germs, whether disease germs or not. In **fumigating,** a room is filled with a gas which has the power of disinfecting. This process will kill only the germs exposed on the surface of things and cannot take the place of a thorough cleansing of the room. It is important to destroy all small objects which may have been soiled or handled by the patient, and which cannot be purified by disinfection or washing. The room should be aired and flooded with sunlight, if possible. After the dust has settled, the woodwork and the plain furniture should be washed, and the floor scrubbed with hot water and soap.

It should be remembered that the time of real danger is

during the disease, not afterwards. Most diseases are much more catching at the beginning than toward the end. Proper care while the disease is going on is of the greatest importance; nothing the health authorities can do afterward will help much if the patient and the nurse have been careless.

Signs of the Beginning of a Communicable Disease.—The fact that many diseases are particularly catching just when they are beginning makes it very important to watch for the onset of disease and to start isolation as soon as possible.

Measles, for instance, begins like an ordinary cold in the head, with sneezing and running nose and eyes. Generally people think it is just a cold, and the child who has it runs about and plays with other children as if nothing were the matter. Yet it has been found that there is far more danger of spreading the germs of measles at this time than there is later, when a rash has appeared and the patient has been put to bed.

Children should never be sent to school, and should not play with other children, when they have any of the signs which may mean an attack of a communicable disease, particularly if there is reason to think they may have been exposed to infection.

The principal signs of the beginning of an attack of communicable disease are as follows:

Coughing	Weak, tired feeling
Sneezing	Watery eyes
Running nose	Headache
Sore throat	Vomiting
Feverishness	Diarrhea
Rash or spots of any kind	Swelling or pain back of or under the ears

Isolation of Exposed or Contact Cases.—In each particular disease, a certain time must elapse between the day when a person first gets the germ into his body, and the day when the actual symptoms of disease appear. This is called the **period of incubation**; during this time the germs are growing in the body until there are enough of them to make the person feel sick. The incubation period varies with different diseases, from a few days to several weeks. The periods for the commoner diseases of children are shown in the table below:

Disease	*Incubation Period*
Chicken pox	11–22 days
German measles	11–22 days
Measles	8–15 days
Mumps	15–22 days
Scarlet fever	7 days
Whooping cough	14 days

When children are known to have been exposed to communicable disease, they should be kept out of school and away from other children until the period of incubation has passed without any signs of the disease appearing. In the case of chicken pox, German measles, measles, mumps, or whooping cough, this is not necessary if the child has had the disease before and is, therefore, immune. In diphtheria, the incubation period is short (from one to five days), but carrier cases are so common that all persons who have been exposed to diphtheria should be examined and have samples taken from their throats by the doctor or health officer. An examination of the samples by a bacteriological test will show whether any diphtheria germs are present.

The Sanitary Conscience.—We shall never stop the suffering that comes from needless communicable disease until people remember how dangerous it is to expose others to infection. It is not a sign of courage for a person to keep up and about when that involves danger to others. The next time you have a cough, or a running nose, or feel half sick, and yet still want to go to a party or to school, remember that you may be coming down with some communicable disease, and that if you mingle with other children you will

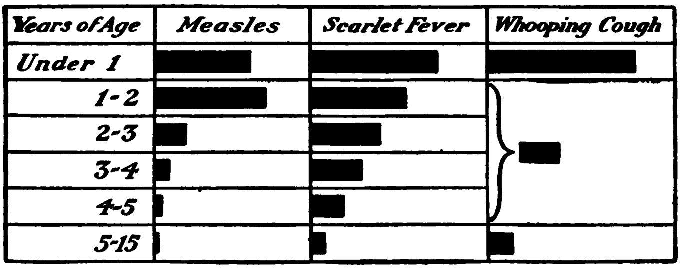

Fig. 114.—The relative fatality from measles, scarlet fever, and whooping cough, for children from one to fifteen years of age. The length of the bars shows the relative proportion of fatal cases to total cases at each age.

be almost sure to infect them, and that some of them may be very ill and may even die as a result.

If you have a light case of whooping cough and feel well enough to go out to play, remember that however light your case may be, some other child may catch the disease from you and be dangerously ill.

Above all, remember that it is to young babies that these diseases are most fatal. Measles and whooping cough are more than five times as deadly in infants under one year of age as in children over five. So, whatever else you do, keep

away from babies and young children, if you have the least sign of illness of any kind.

On the other hand, if you are well yourself, it is wise to keep, as much as you can, away from others who seem to be "coming down" with some communicable disease. In epidemics like the outbreak of influenza which occurred in 1918, one should remain at home as much as possible and avoid crowds and public gatherings.

Questions for Discussion and Review

1. What do we mean by isolation? What do we mean by quarantine?

2. Why do we have quarantine stations in all our big ports? Is complete quarantine usually required nowadays? Explain.

3. What precautions must the doctor and the nurse take so that they will not carry germs to others?

4. Why is it a good plan for a patient suffering from a communicable disease to use old soft muslin or cheesecloth in place of handkerchiefs?

5. Suppose that a nurse was holding a spoon to the mouth of a child that had diphtheria, and the child coughed violently. Suppose that the nurse then laid the spoon on the table, went to the bathroom, and turned the faucet with the same hand that had held the spoon. Would this be good isolation?

6. In what diseases is isolation considered necessary?

7. Which diseases are transmitted by the fine spray from mouth and nose?

8. What determines the length of time a patient must be isolated on account of a communicable disease?

9. What is meant by disinfection? Sterilization? Fumigation?

10. What should be done to clean a room after the patient has left it?

11. At what stage in a disease is there usually greatest danger of passing on the disease.

12. In a school where there had been cases of measles, a child who sneezed and coughed and who had running eyes and nose was sent home by the school doctor. Explain.

13. What is the incubation period of a disease?

14. What are some of the common signs of the beginning of an attack of communicable disease?

15. Mary has measles. Her brother John had the disease four years ago, and her brother Walter has never had it. The Health Officer said that John could go to school, but that Walter must stay out for fifteen days after the day on which he last played with Mary. Why?

16. Which are more likely to catch any communicable disease, little children or grown people? What do you think of exposing children to measles or whooping cough in order that they may "get it over with"?

17. How can we be careful about passing on a disease to other people?

18. How can every one help in the campaign to stamp out disease?

19. What is the "sanitary conscience"?

CHAPTER XXV

IMMUNITY AND HOW WE CAN CONTROL IT

Natural and Artificial Immunity.—**Vital resistance,** or the natural power of the body to fight against invading microbes, varies greatly with different people. A high or a low degree of vital resistance sometimes runs in certain families. It was probably this fact that led people to think that tuberculosis could be inherited. A germ disease cannot, properly speaking, be inherited, although the germ can be passed from parent to child; but a low vital resistance against disease can be inherited.

Besides this sort of general vital resistance, there is a very special kind of vital resistance, or **immunity,** which follows an attack of a particular disease. Every such attack, as we have learned, is a real battle between the disease germ and the human body. As soon as the germ enters, the tissues begin to form substances to fight against it, and the white blood cells set out to destroy it. When a person recovers, it is because the white cells and the substances formed to kill the disease germs have prevailed. Sometimes the body retains the power of killing this particular kind of germ, or destroying its poison, for some time after recovery, and after certain diseases it retains this power for life.

In several diseases, thanks to the brilliant discoveries of physicians and bacteriologists, it is possible to make people immune beforehand, or to help them recover after the disease has set in. This is accomplished by the use of certain substances called **vaccines** (văk′ sĭns) and **antitoxic**

sera (singular, sē′ rŭm). These vaccines and sera produce an artificial immunity in the body, similar to the immunity that follows recovery from an attack of communicable disease.

Vaccination against Smallpox.—The earliest, and one of the most important, vaccines ever discovered is that used

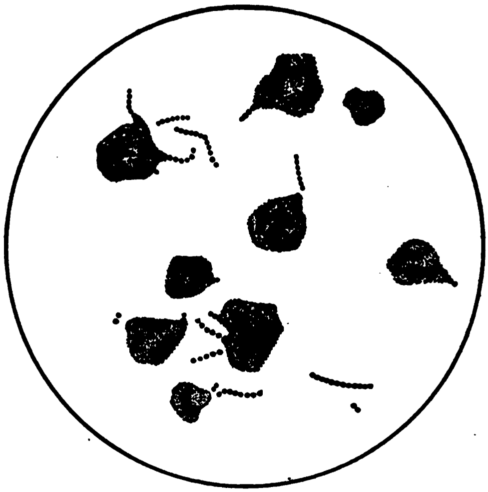

Fig. 115.—The large greyish bodies with darker nuclei are the soldier cells of the blood in the act of destroying chains of invading cocci.

for protection against smallpox. Smallpox used to be one of the most terrible of all diseases until in 1798 Edward Jenner, an English physician, discovered this method of preventing it. Jenner was a country doctor in a dairy farm district. It had been noticed that the cows in this region suffered from a very mild disease, somewhat like smallpox, called cow pox. Little swellings, like blisters, are found on the skin of cows that have this disease. Jenner discovered that the lymph from these swellings, if rubbed into scratches

in the human skin, had the wonderful power of giving a person immunity against smallpox. It has been said that this discovery of Jenner's was the greatest single practical benefit ever bestowed by one man upon the human race.

Fig. 116.—Edward Jenner (1749-1823), who introduced the practice of vaccination against smallpox.

As soon as vaccination was generally introduced, the dreaded epidemics of smallpox ceased, and this disease now exists only so far as vaccination is neglected. During the eight years before the American army entered Havana, there were 3132 deaths from smallpox in the city; during the next eight years, when vaccination was enforced, there were seven.

Vaccination has conquered smallpox so successfully that people have almost forgotten what a terrible disease it was, and some of them have grown careless about vaccination. Then, too, there are others who object to being vaccinated for fear some infection may get into the wound. All vaccine used in the United States is now tested as to its purity by the national government, and there is no danger from its use, provided that the place where the vaccine is rubbed into the arm or leg is kept clean and free from dirt germs. The protective effect of vaccination wears off after a time. Every child should therefore be vaccinated when about a year old, and again at about the seventh year.

Pasteur's Work on Vaccines.—For a long time Jenner's vaccine was the only substance of its kind known. No one had any idea that the principle he had discovered could be applied to other diseases as well. It was Pasteur who laid the foundation for the many other treatments of the kind which we have to-day.

While Pasteur was studying a disease of fowls called chicken cholera, he was away from the laboratory for a time, and some of his cultures of the germs dried up. He found that these germs, though still alive, were so weakened that they could no longer cause disease. Fowls treated with these weak germs, however, were found afterward to be immune against fresh, powerful cultures. Here was a great and promising discovery; and Pasteur at once began to study whether he could produce vaccines for other diseases in the same way.

He succeeded at last in doing this with a disease of cattle called anthrax, and on a famous day in 1881 he demonstrated to a great company of doubting farmers and doctors that he could successfully protect cattle against anthrax by

treatment with his vaccine, which consisted of a culture of anthrax germs that had been weakened by heating. By this discovery he has saved millions of animals, since that time, from suffering and death. Above all, he established the fact that weakened disease germs (or in some cases the dead disease germs) can stimulate the tissues of the human body and the white cells in the blood so that they can

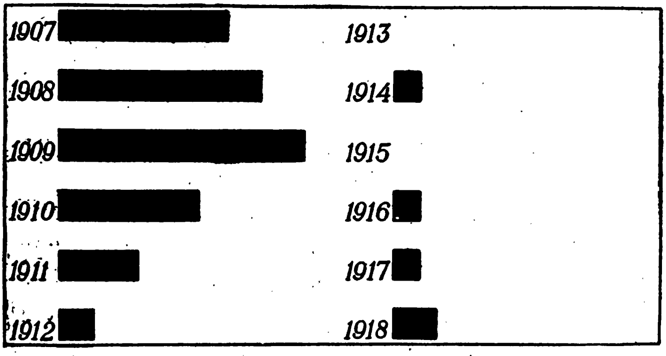

Fig. 117.—Death rates from typhoid fever in the United States army. Vaccination was voluntary in 1909 and 1910, and was made compulsory in 1911.

fight successfully against that particular kind of germ, just as an actual attack of the disease would do.

Vaccination against Typhoid Fever.—One of the most successful of the vaccines discovered in recent years is that used to protect against typhoid fever. Its effects in controlling this disease in the American army have been most remarkable (see Fig. 117). In 1913 there was not a single death from typhoid fever among the United States troops. Vaccines against typhoid, cholera, and other diseases were used with striking success in the European armies in 1914 and succeeding years.

The Treatment of Diphtheria by Antitoxin.—Vaccines, as we have seen, are weakened or dead germs which stimulate the body tissues to form substances that will destroy the particular germ used, or its poisons. Vaccines are generally used beforehand as preventives of any future attack of disease.

Another way of controlling immunity is by the use of antitoxic sera, or **antitoxins,** as they are often called, of which diphtheria antitoxin is the best example. Diphtheria antitoxin is made by introducing into the body of a horse the poison, or toxin, formed by the diphtheria germ. The toxin acts somewhat like a vaccine and stimulates the tissues of the horse to form an antitoxin, a substance which destroys this particular toxin. Then some of the blood of the horse is drawn off, the clear part or serum is separated and purified, and this serum (containing the antitoxin formed by the tissues of the horse) can be put into the body of a person suffering from diphtheria, to destroy the poisons of the germ.

Diphtheria antitoxin was introduced into the United States by the New York City Department of Health in 1894, and it has reduced the death rate from diphtheria in that city from 155 deaths for every hundred thousand of the population to 24. The antitoxin is of comparatively little use when the disease has gone on for a long while and the body has become severely poisoned; but if it is used as soon as the disease begins, it is a practically certain cure.

When a case of diphtheria occurs in a family or in a school, the children and grown people who have been exposed to infection and are likely to come down with the disease, may be given doses of antitoxin to head it off.

Keeping up the General Vital Resistance.—It must be remembered that, aside from the special immunity which follows an attack of a particular disease, or treatment with a vaccine or serum, there is a considerable vital resistance against most diseases that goes with a general condition of good health. All the things that hygienic living demands—such as good food, fresh air, exercise, and rest—help to build up vital resistance.

Alcohol and Vital Resistance.—Alcohol and other poisons lower vital resistance and make the body a more ready prey to disease germs.

Observers who have studied the effect of alcohol on the power of animals to form immune substances in the blood, report that it reduces this power. As a matter of practical experience, physicians find that in fighting against such a disease as typhoid fever, where the struggle is a long and severe one, the person who has used alcohol to any considerable extent is heavily handicapped.

The importance of the part played by vital resistance varies a great deal in different diseases. In smallpox, for instance, there is almost no natural vital resistance. Every one who has not had smallpox already, or has not been protected by vaccination, will take this disease if the germ enters his body. In pneumonia, on the other hand, many people may have the germs in their noses or throats without having pneumonia—provided they are strong and well. Just as soon as the general vital resistance is lowered, the pneumonia germ is likely to grow and produce disease. In such a case as this, the effect of indulgence in alcoholic drinks is particularly serious; the danger of pneumonia in a person poisoned by alcohol is well recognized by all physicians.

Questions for Discussion and Review

1. How does the body fight disease?

2. Can vital resistance be inherited? What would be meant if any one said, "Catching cold seems to run in a family?"

3. What is immunity? When you have a disease, what change takes place within your body, to make you immune?

4. Can you ever be made immune without having a disease? How? Which is better—to become immune before you are exposed to a disease or after you have had it?

5. What diseases do you know of, from which you can be made immune without having the diseases?

6. What does vaccination do to the body? Why does the law almost everywhere require that a child must be vaccinated against smallpox before he can enter the public schools?

7. How may all danger in vaccination be avoided?

8. Who discovered the power of vaccination against smallpox? Who found that the theory could be applied to diseases other than smallpox? How was each discovery made?

9. What is the difference between a vaccine and an antitoxic serum?

10. How is diphtheria antitoxin made? When is it used? Is the antitoxin of any use when diphtheria is well started?

11. What has the use of diphtheria antitoxin accomplished in New York City? What has typhoid vaccine accomplished in the United States army?

12. How does the power of vital resistance vary in different diseases?

13. How does hygienic living lessen the chances of catching a communicable disease?

CHAPTER XXVI

TUBERCULOSIS

Tuberculosis, the Great White Plague.—One of the communicable diseases is so much more common and so much more deadly than any of the others that it deserves a special chapter. This is tuberculosis, sometimes called the Great White Plague.

Tuberculosis is caused by a bacterium, which may grow in a great many different parts of the body, although it is most likely to be found in the lungs, causing tuberculosis of the lungs, or consumption. The germ does not grow all through the lungs in this disease but here and there at special points, where there form hard little knots or **tubercles,** from which the disease was named.

Tuberculosis of the bones is not uncommon among children, and a great many of the lame people we see on the streets are crippled from this cause.

The course of this disease is very slow, and it may take months or years to develop. When the germ is first gaining headway against the natural defenses of the body, the person begins to feel tired and weak, to lose weight and appetite, to feel feverish toward evening, and, in the case of consumption, to have a cough that does not yield to treatment.

If proper steps are not taken to check the disease, it continues and grows worse. People between eighteen and forty-five suffer particularly from tuberculosis. It causes the death of about one third of all the people who die be-

tween these ages, and each year it kills about 150,000 people in the United States—more than were killed in battle in the whole Civil War.

How the Germ of Tuberculosis Spreads.—The primary cause of tuberculosis is always the microbe itself. This germ is discharged in the spray and sputum coughed out by consumptives, and in most cases of the disease, infection results from getting these human discharges into the mouth. Sometimes the germ is inhaled in dust, but it is more frequently transferred from one person to another by the various kinds of contact described in Chapter XXI.

A great many cattle suffer from tuberculosis, and children may become infected by drinking the milk of tuberculous cows.

How to Prevent the Spread of the Germ of Tuberculosis. To prevent the spread of tuberculosis, it is necessary, first of all, to prevent the spread of the germs discharged from the mouths of consumptives; and second, to pasteurize the milk of all cows not certainly known to be free from the disease.

The careless consumptive is a great danger to his family and associates, but one who is always careful to destroy his sputum and to avoid coughing out mouth spray into the air, need not be a menace to the health and life of others. The consumptive should always cough into a cloth or handkerchief, or a paper napkin which can be burned, and all sputum should be received in paper cups and burned at the end of the day. If handkerchiefs are used, they should not be put into a laundry bag or basket with other soiled linen, but should be boiled for twenty minutes in a strong soapsuds solution. When all these precautions are taken, it is not dangerous to live or work with a careful consumptive.

All rooms or apartments that have been occupied by persons suffering from tuberculosis should, upon the removal of the patient, be thoroughly cleansed and renovated by airing and exposing to sunlight, if possible, by washing woodwork and plain furniture, and by scrubbing the floor with soap and water. Renovation or repapering and painting is sometimes also desirable.

Vital Resistance and Tuberculosis.—Tuberculosis is a disease in which vital resistance plays an especially important part. The germ is unfortunately very common; in fact, almost every individual, sooner or later, is slightly infected with it.

This does not mean that every one has tuberculosis, in the sense of suffering from actual disease. The human body has a considerable power of defending itself against this invader, and a few germs entering the healthy body are quickly overcome. It is when a great many germs are taken in, and particularly when the strength is reduced by attacks of other diseases, or when resistance is lowered by intemperate habits, by living and working in overheated rooms, by eating insufficient food, or by breathing sharp dust particles, that the invisible enemy overcomes the defenses of the body.

People who have recovered from tuberculosis, and those in whose family there has been a case, should be especially on guard against allowing their vital resistance to become weakened.

How to Build up Vital Resistance against Tuberculosis. Tuberculosis is primarily a disease of those who work too hard and get too little food, of those who live in dark, unventilated tenements and work in dusty factories, of those who do not get enough exercise, fresh air, and sunlight.

We can largely control tuberculosis by applying the ordinary principles of hygiene. Knowledge of the calorie-value and cost of food makes it possible to secure a nourishing diet

Fig. 118.—A crowded tenement district—where the bacillus of tuberculosis works its ravages unless checked by vigorous preventive measures.

even with a small income. Fresh, cool air can generally be secured by opening the windows. Every effort should be made to have the bedroom well ventilated, and to keep the windows open at night all the year round. Suffi-

cient sleep could be enjoyed by most people, if they would realize that one cannot work all day and play half the night. Indoor workers can get at least some outdoor exercise by walking to their place of work.

Industrial Tuberculosis.—Among the most important causes of tuberculosis are the unsanitary conditions of

Fig. 119.—A factory equipped with hoods and exhaust ducts to remove dangerous dust from grinding and polishing wheels.

factory life. An overheated, unventilated workshop is certain to lower vital resistance and make the worker an easy prey to the tuberculosis germ, particularly if he is weakened by long hours of labor. An especially dangerous thing about some industries is the fact that the air of the workshops is full of fine particles of mineral or metallic dust. These dust particles are inhaled and injure the delicate

tissues of the lung, so that tuberculosis germs find it easy to grow there. The workers in some of these industries—granite workers and grinders, for instance—are two or three times as likely to contract tuberculosis as are people who work at less dangerous trades.

In all such places there should be special pipes with exhaust fans to draw off the dust from the air. Where this cannot be done, the worker should wear a respirator over his mouth to keep out the deadly dust particles.

Alcohol and Tuberculosis.—Alcohol, of course, lowers vital resistance against disease of all sorts, and since vital resistance plays so important a part in the fight against tuberculosis, the effect of alcohol is especially serious in this disease. Again and again we find that alcohol has been the thing that has weakened a man so that he could no longer defend himself against this enemy which is always waiting. The avoidance of alcoholic drinks is an essential part of the campaign against the Great White Plague. The International Congress of Tuberculosis recognized this fact when it adopted the resolution: "We strongly emphasize the necessity and importance of combining the fight against tuberculosis with the struggle against alcoholism."

The Cure of Tuberculosis.—Just as the tuberculosis germ fails to gain a real foothold in the body of a thoroughly healthy person, so by proper hygienic treatment it can be conquered even after it has begun its work.

There are no medicines, in the ordinary sense, that will cure tuberculosis. All so-called "Consumption Cures" are frauds which waste the money of their victims and do immeasurable harm by the loss of precious time. The cure for tuberculosis is *hygienic living* under the advice of a competent physician—properly directed rest and exercise,

plenty of fresh air, and a sufficient amount of wholesome food. If such treatment is taken *early in the disease*, tuberculosis can generally be cured.

The cure does not depend on any special climate, as was once thought to be the case. With proper treatment, people get well in all parts of the United States, and the strain and

Fig. 120.—A tuberculosis sanatorium on the slope of a mountain. The patients sleep in the small tents, which are fully equipped for ventilation, and at the same time afford protection from the weather.

expense of a long journey are usually unnecessary. Treatment can be carried out best, however, in a sanatorium or hospital established especially for the cure of tuberculosis. In such a hospital, where there is constant medical supervision and nursing care, the patient stands a far better chance of recovery than anywhere else. The care of the patient in a hospital also ensures the protection of family and friends,

who might be in danger of infection if the patient were cared for carelessly in the home.

Where, for any reason, hospital treatment is impossible, the cure can often be taken at home, if the advice of the physician is carefully followed. A tuberculous patient should always sleep alone and, whenever possible, should have a separate bedroom. Both the bedroom and the living room should have as much sunlight as possible, and should always have an abundance of fresh air. The windows should be open day and night.

Many consumptives have benefited greatly from sleeping out of doors—in tents, on roofs, or on piazzas (see Fig. 58). A sleeping porch, protected from storms by an awning, can be built at small expense. If sleeping out of doors is not feasible, a window tent may be substituted; this is particularly suitable for winter. With plenty of bed clothing and a woolen hood over the head, tuberculous patients often sleep out of doors all winter when the temperature is well below zero, and seem to benefit by it.

The Importance of Early Treatment.—The main thing is to begin the treatment of tuberculosis *as soon as possible.* In the family or immediate circle of each person known to have active tuberculosis, there is generally another early, unrecognized case. If such cases could be discovered, they could easily be cured. The time to put out a fire, or to control a disease, is before it gets well under way. When tuberculosis has gone far, it cannot usually be checked, but if the disease is attacked early there is every reason to be hopeful. Any one who has a cough that hangs on, or who feels run-down and tired without knowing why, or who grows feverish in the afternoon, should consult a physician at once, so that if the enemy is present it may be discovered in time.

The Campaign against Tuberculosis.—Since about 1895, a strong, organized campaign has been carried on against tuberculosis by the establishment of sanatoria and hospitals, dispensaries, open-air schools, and day camps; by the work of Boards of Health in finding early cases of the disease and getting treatment for them; and by the education of the

Fig. 121.—An open-air schoolroom.

public through exhibits, lectures, and in other ways, as to the measures whereby the disease can be controlled.

The result of this campaign, and of a general improvement in living conditions, is that the death rate from tuberculosis has been reduced to about one half of what it was fifty years ago. There is still much to be done, however, for even to-day tuberculosis remains the largest single cause of preventable disease.

Questions for Discussion and Review

1. What causes tuberculosis? From what does it get its name?

2. What part of the body is most often affected in this disease? What other parts of the body are sometimes affected?

3. Is tuberculosis caught from other people? In what ways does it differ from other communicable diseases, such as tonsilitis or measles?

4. What are some of the first symptoms of tuberculosis?

5. Between what ages does it usually develop?

6. What percentage of deaths are caused by it?

7. Explain how tuberculosis may be carried from one person to another by "Fingers." By "Food" By "Flies."

8. What can the patient do to save others from getting tuberculosis? What can the family do? What can you do?

9. What effect does vital resistance have upon tuberculosis?

10. Do you suppose that you have ever had a tubercle bacillus in your body? Why have you not developed tuberculosis?

11. People who work in close, dark places where the air is bad are likely to contract tuberculosis. Why?

12. People who work beyond their strength with insufficient food often have tuberculosis. Why?

13. Those whose work makes it necessary for them to breathe, constantly, air which is full of sharp particles are very likely to develop tuberculosis. Why?

14. If there is a big factory in your town, find out about the lighting, air, rest rooms, and general care of the employees. How can you justify increasing the running expenses of the factory for sanitation?

15. What effect does the use of alcohol have upon the development of tuberculosis?

16. Why can a tuberculosis cure be carried out better in a sanatorium than at home?

17. Why is it necessary to begin treatment in the very earliest stages of the disease?

18. How can the education of the public help to wipe out tuberculosis?

19. A laundress had to support her husband, who was confined to his bed with tuberculosis. They lived in one room, and she had to do the washing, drying, and ironing in that place. What harm would this do to the husband? What danger was there to others?

20. Has there ever been a Red Cross Seal Campaign in your town? Find out all you can about it.

CHAPTER XXVII

KEEPING THE BABY WELL

The Care of the Baby.—In many families there can be no regular nurse, and much of the care of the baby must come on the older children. Girls, and sometimes boys too, may be very helpful in this work, and so it is particularly important that children should know how to keep the baby well.

A baby is much more delicate than a grown person, and many serious illnesses of babies occur largely as a result of improper care. Most of this sickness is quite needless. Health is the normal condition for a baby, just as it is for a grown person. Little children become sick because they are given the wrong kind of food or because they are not given the right kind of clothing or airing—because people do not know how to care for them.

The girls who act as little mothers to their small brothers and sisters, if they will learn how to take good care of babies, can be of great help in the national movement to save infants' lives.

Feeding the Baby.—The most important factor in keeping the baby well is proper feeding; and there is only one thoroughly safe food for a baby under nine months old—mother's milk. Cow's milk is different from human milk. It contains more fat and protein and less sugar than the baby needs. Above all, it generally contains germs which poison the infant, whose delicate body is not yet ready to

fight against them. A young baby is very sensitive to heat, and in summer the combination of heat and uncooked cow's milk is likely to lead to serious and perhaps fatal attacks of "summer complaint." Out of an equal number of babies fed on the bottle and on mother's milk, ten times as many of the bottle-fed babies die..

When a baby cannot be given mother's milk, it should be fed, not on prepared baby foods, but on clean cow's milk, modified. Modified milk is cow's milk to which water, lime water, and sugar have been added according to the needs of the individual baby so that it will have the chemical composition the baby needs. The formula for modifying the milk must be changed from month to month, according to directions of the family physician or the doctor at the dispensary or Infant Welfare Station.

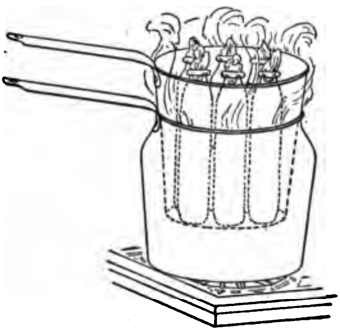

Fig. 122.—Pasteurizing the baby's milk in an ordinary double-cooker.

The cow's milk used should be the best and cleanest milk obtainable. It should be modified and then put in nursing bottles, stoppered with clean cotton batting, and pasteurized as described on page 253. On no account should milk be given to a child without pasteurization, for no one can tell when the cleanest, freshest milk may contain germs of tuberculosis from the cow, or germs of scarlet fever or sore throat from some unsuspected human carrier.

After pasteurizing, the milk should be cooled at once by placing the bottles in cold water and then on ice. The

milk should, of course, be warmed again before it is given to the child.

All patent "baby foods" should be avoided, unless ordered by the doctor for a baby in need of a special diet. They are expensive, and the babies fed on them are, as a rule, more likely to be ill than those fed on cow's milk.

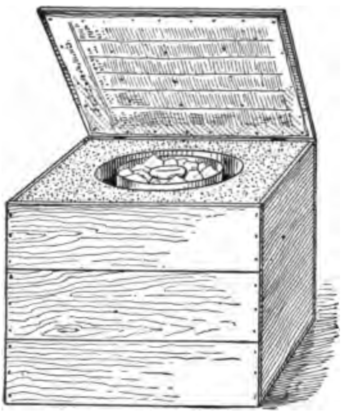

Fig. 123.—A home-made ice box.

Take a deep box about 18 inches square and put 3 inches of sawdust in the bottom. Stand a pail on the sawdust and fill up the box with sawdust around the pail. Place a second smaller pail inside the larger one and put the milk bottle, surrounded by cracked ice, in this inner pail. Nail several thicknesses of newspaper on the under surface of the cover of the box.

The baby should be fed only at regular times, as specified for each age by the doctor or the Board of Health, and should never be fed at other times merely because it cries.

The baby needs water between feedings. This water should always be boiled first to kill any germs in it, and then cooled.

For the first nine months of its life, a baby should have no solid food.

Clothing and Bathing the Baby.—The baby is very sensitive to both heat and cold. When it is taken out in cold weather, it should wear a warm woolen cap and a coat long enough to turn up at the bottom and button, making a bag. When the baby is in the baby carriage, it should be covered with a blanket.

In summer the baby's clothes should be as light as possi-

ble. Even in cold weather, overdressing is quite as dangerous as underdressing, since clothing that is too heavy weakens the vital resistance of the child and makes it liable

Fig. 124.—The baby's bath. The temperature is being tested with a thermometer.

to colds and pneumonia and other diseases of the lungs and throat.

Every baby should be bathed at least once a day, care being taken that the water used is neither too hot nor too cold. Further information about clothing and bathing the baby may be obtained from the doctor or from special government bulletins.

Fresh Air for the Baby.—After the baby is three months old, much of its time should be spent outdoors. A healthy baby should be kept in the open air at least four hours each day, even in winter (properly clothed), except when it is colder than 22°F. The baby's eyes should be carefully protected from direct sunlight. Too often we see a child in its baby carriage blinking straight into the sun.

The sleeping room for a young baby should be kept at about 65°. After the baby is three months old, the temperature may be allowed to fall to 55°, and during the second year to 45°. In summer, the baby's room should be kept as cool as possible with awnings and shutters. The windows should be open day and night in summer, and in winter the room should be aired two or three times a day. Windows and doors should be screened against flies and other disease-carrying insects. If screens are not available, mosquito netting may be tacked on the outside of the windows.

The surroundings of the home should be free from uncovered garbage and rubbish, which attract flies and other insects.

Babies usually catch colds (which may be very serious with them) because they have been near some one who has a cold, or because they have been kept too warm and then suddenly taken into a cold room or placed in a draft.

The Baby's Naps.—The baby needs more sleep than an older child. It should be trained to sleep at regular hours and should never be disturbed at these rest times.

The baby should get two naps a day and at least twelve hours of sleep at night. It needs twenty hours of sleep out of every twenty-four in the first month, and not less than sixteen hours out of twenty-four up to the twelfth month.

It should not sleep on a feather pillow, but in a bed or crib by itself—never in bed with its mother. If no crib is available, a clothes basket or a large box is a good substitute. If the baby cries when it should be asleep, it is probably sick, overfed, or hungry; or it has been badly trained.

Under no circumstances should soothing sirups be given to a baby. They contain opium or other drugs, and are dangerous. Pacifiers should not be used, as they injure the shape of the baby's jaw while its soft parts are forming.

Gentleness with the Baby.—As the baby's muscles are weak, it should never be handled except with the greatest care. To lift a young baby, one hand should be slipped under the back beneath the shoulders, with the fingers spread so as to support the neck and head, while the other hand lifts the feet and legs. The baby should never be pulled about by the arms.

The baby's nervous system is delicate. It should not be strained by rocking and jouncing, or by unnecessary handling. Remember that the baby is not a plaything.

Summer Care of Babies.—The summer is a very trying time for babies, particularly for those who cannot get mother's milk. The combined effect of improper food (unheated cow's milk) and high temperature is almost sure to cause digestive trouble. If cow's milk is given to babies at this season, it is particularly important that it should be carefully pasteurized. The baby's clothing should be made very light in summer. The infant should be kept out in the fresh air (not in the sun), and when indoors it should be kept in a well-ventilated room. If the baby is sick, if it vomits, if its skin is cold or flushed and hot from fever, if it is restless, nervous, and crying, or exhausted and limp, a doctor should be sent for at once.

Protecting the Baby from Communicable Disease.—All communicable diseases are likely to be severe in a baby, and the greatest care should be taken to protect it from dangers of this sort. No one with a cold or cough or any other sign of sickness should come near the baby, if it can be helped. A little cold in a big person may cause a very big cold in a

Fig. 125.—The Little Mothers' League learns how to give the baby its bath.

little person. The baby should never be kissed on the mouth. It should never be allowed to crawl on a dirty floor or play with dirty toys.

The Infant Welfare Station and Its Work.—The most important thing that can be done in any community to prevent the needless sickness of babies is to establish Infant Welfare Stations. At these places, the mothers of young babies are taught how to take care of them. The

babies are brought to the station once a week, to be weighed and examined by the doctor. Each mother is told just what her baby needs, and is shown just how it should be dressed and bathed and cared for. The nurse from the station visits the mother in the home, and helps her to carry out the directions of the doctor.

In New York City such infant welfare work reduced the death rate of babies under one year of age from 144 deaths for every 1000 births in 1907, to 94 deaths for every 1000 births in 1914, which meant a saving of over 5000 infants' lives a year.

Little Mothers' Leagues.—In order to teach girls how to care for the babies in the household, Little Mothers' Leagues have been organized in the schools of many cities. By means of talks and demonstrations given by the school physician, school nurse, or teacher, the members of these leagues are taught the essentials of baby welfare. The girls have their own organization and elect their own officers. Each one agrees "to do some one thing each day to help a baby."

There are few finer things that a school can do for its pupils than the organization of a Little Mothers' League.[1]

Questions for Discussion and Review

1. What is meant by the Campaign for Better Babies?
2. Do you think that it would be a good plan for the older brothers, as well as sisters, to learn how to take care of the baby?
3. Why is the kind of food that is given to a baby important?

[1] Detailed information as to the care of babies and the organization of Little Mothers' Leagues can be obtained by writing to the Children's Bureau, Washington, D. C., and to your state or city Board of Health.

What danger is there in cow's milk? What have we learned about the care of milk?

4. Why must we be careful to use clean nursing bottles and nipples for a baby?

5. Should a baby be given food any time when it cries?

6. Why should a baby's clothing vary according to the weather or the temperature of the room? What is the danger in too heavy clothing? In insufficient clothing?

7. When a baby is bathed, should the water be hot or cold? When he is taken out of the water, he should be covered up at once while being dried. Why? Why do we dry a baby by patting rather than by rubbing, as we do for ourselves?

8. If you saw a baby crying, with the sun in his eyes, how could you explain to the nurse or person in charge what was wrong with the baby? Would you feel that it was your duty to say anything about it?

9. Why should you be especially careful not to go near a baby when you have a bad cold?

10. How many hours of the day should a baby sleep?

11. How can you apply to the subject of the baby's training in sleeping, feeding, etc., the rules for habit formation which you learned in studying about the nervous system?

12. Why are soothing sirups dangerous to babies?

13. What is the proper way to lift a baby?

14. Is rocking good for babies? Is it right to jump them up and down to keep them amused? Explain.

15. Why is summer the most dangerous time for babies? Find out why people always dread the baby's second summer.

16. What things can you do to make a baby more comfortable in summer?

17. What is an Infant Welfare Station?

18. Why do many cities form Little Mothers' Leagues among their school children?

CHAPTER XXVIII

MUNICIPAL SANITATION

Community Health Work.—Most of the problems so far discussed in this book have been problems of individual conduct. We can all of us do much to keep our bodies in vigorous health and to protect them against disease germs coming from outside. But there are other things necessary for good health that are beyond the control of the individual, particularly in the case of those who live crowded together in cities and towns.

You must have pure water to drink; but in a place where many people live and where the soil is necessarily more or less polluted, you cannot get safe water by digging a well for yourself. You ought not to drink impure milk; but your father could hardly go every morning to the dairy to make sure that everything is clean and right. If your neighbor has scarlet fever, the members of the family should not be allowed to carry the disease to others, but you alone could hardly force your neighbor to take the proper precautions. This is where the community, the city, or the town steps in and does collectively the things which individuals could not do for themselves.

Problems of Municipal Sanitation.—The special work of the Board of Health in controlling communicable disease, supervising food supplies, and educating the public in the principles of healthy living will be discussed in the next chapter. There is a group of health problems, however, which have to do with engineering rather than with med-

icine, and which are often grouped under the head of Municipal Sanitation, though they must receive attention not only in cities but also in towns and in thickly settled villages. These are the problems of public water supply, sewage disposal, refuse disposal, and street cleaning.

The Public Water Supply.—An ample supply of pure water is one of the first needs of any community, and in a large city the problem of obtaining such a supply is by no means a simple one.

The amount of water used by American cities is enormous, much larger than it need be, because a great deal is wasted. A large part of this waste comes from taps which are left running, or from taps or flush tanks which are in bad repair so that they trickle all the time. The good citizen will see that this does not happen in his house, for all the water wasted costs the taxpayer money.

Various Kinds of Water Supply.—All of our water supply comes first of all from the clouds, in the form of rain. Individual houses may collect rain directly as it falls on the roof and carry it by gutters to a cistern—a good arrangement if the cistern is kept clean.

When the rain falls to the earth, part of it runs over the surface of the ground into small brooks, and thence into larger streams or ponds. Many cities get their drinking water from these streams and ponds, which are called **surface supplies.** Sometimes, if the stream or pond is high up in the hills, the water will flow down to the city by **gravity** (the attraction of the earth which causes water to flow from a higher to a lower level). All that need then be done is to build a large pipe or aqueduct which branches out into smaller and smaller pipes in the city streets, and finally into individual pipes running into each house. Where this

kind of gravity supply cannot be obtained, surface water may be pumped up from a neighboring stream into the city pipes by great steam pumps.

While much of the rain water runs off from the surface of the ground, some of it trickles down into the earth and becomes **ground water.** If men dig down far enough into

Fig. 126.—Building the great aqueduct which supplies the City of New York with water from the Catskills.

the earth anywhere, they will finally come to this ground water trickling along through the soil toward the ocean or the bed of some river or lake. In low places, the ground water is at the surface or very near the surface, while in other places it may be necessary to go down thousands of feet before striking water.

If a hole is dug or a pipe is driven down to a point below the ground water level, the ground water will flow into the

hole or pipe and make a well. Cities may get their supply of water by driving a series of such wells and pumping the water up from them. This forms what is called a ground water supply.

Purification of Public Water Supplies.—The raindrop, as it first forms in the clouds, is pure water. In falling through the air, it picks up dust particles floating there and washes the air so as to give us the bright, clear days we have after a heavy rain. There are, however, practically no disease germs in the upper air, so that in this respect the rain water is still pure when it reaches the earth.

As soon as the raindrop touches the ground, its pollution begins. You may have seen the swollen brooks just after a heavy rain, muddy with the dirt which the rain had washed from the surface of the earth. Along with the rest of the dirt, it is quite likely that human excretions have been washed into the brook. Many of the larger streams and ponds also receive a direct discharge from house drains and sewers.

The danger from water supplies polluted in these ways has been pointed out in Chapter XXII. There is now no excuse for running any such risks, since we have simple and cheap methods of making water safe to drink.

There are three principal ways of purifying polluted waters: by storage, filtration, and disinfection.

Storage Reservoirs.—If the water of a polluted stream flows into a large lake or reservoir and passes very slowly through it, taking several weeks to go from one end to the other, practically all the disease germs will die out. This is called purification by **storage.** It is often an effective way of getting a good water supply. There is danger, however, that floods after a heavy rain or surface currents caused by

the wind may carry water quickly across such a reservoir, so that the expected purification will not be secured.

Filtering the Water Supply.—A more certain way of getting a safe public water supply is by **filtration.** A city

Fig. 127.—A reservoir for storing a part of the water supply of New York City. The great dam holds back the water and creates an artificial lake.

water filter does its work more thoroughly than the little filters on the tap in the house, which take out sticks and large particles of dirt, but not bacteria. The city filters are great beds of sand, each bed sometimes an acre in area. As the water slowly trickles through these sand beds, the bacteria are caught on the surfaces of the sand grains. Such a filter will make even polluted river water clean, pure, and safe to drink. In some filters, chemicals are added to

the water; they make a deposit on the surface of the sand which helps to strain out the bacteria.

Disinfecting the Water Supply.—Water supplies may also be purified by **disinfection** with certain chemicals, particularly chlorine. Very minute amounts of these chemicals will destroy the disease germs and most of the other germs

Fig. 128.—A municipal water filter at Lawrence, Mass., installed as a result of the typhoid epidemic in the Merrimac River Valley in 1890–1891.

in water, without harming it in any way. This is such a cheap way of making water safe that any city can afford it.

Hard and Soft Waters.—Water which contains a large amount of certain mineral matters in solution is called **hard water.** A great deal of soap must be used to get a lather with hard water, and the mineral matter in such waters collects on the walls of steam boilers and injures them. The taste is also unpleasant unless one is used to it.

In many parts of the country where hard waters are found, the city **softens** the water or takes out the substances that cause hardness by special chemical treatment.

Sewerage.—Some of the difficulties in disposing of wastes from houses in the country have been mentioned in Chapter XXII. In a thickly settled community, it is necessary to provide in some special way for the removal of such materials. Just as clean water is brought to each house in the water pipes, so the soiled water from toilet, bath, and kitchen sink is carried away by another system of pipes, the sewers. It is a great advantage to have sewers under the streets to carry off all the liquid wastes from the houses. A sewerage system brings up a new problem for the city, however, for at the end of the big sewer, into which the little sewers empty, there is a river of sewage that must somehow be disposed of.

Sewage Disposal.—The simplest thing to do with sewage is to discharge it into the nearest stream, lake, or harbor. If there are no bathing beaches or oyster beds near at hand, and if the stream or lake is large and the amount of sewage small, the sewage will disappear in the water without causing any trouble. The sewage matter in such a case is destroyed and changed to an odorless liquid form by the action of certain bacteria which live upon it. These bacteria need oxygen to carry on the work, and there must be plenty of oxygen in the water, in order that this kind of sewage disposal may succeed. If a large amount of sewage is put into a small stream or pond, the oxygen dissolved in the water may all be used up; and then another kind of bacteria, which live where there is no oxygen, begin to grow. These bacteria cause a different kind of change in the sewage, the change we call **putrefaction,** which produces

foul odors. A body of water which has too much sewage discharged into it becomes ill-smelling and a nuisance to the whole neighborhood.

In order to avoid this condition, cities that are not situated on very large bodies of water usually have to purify their sewage before they discharge it. Sometimes all that is necessary is to strain out the solid matter by passing the sewage through fine screens, or to let the solids

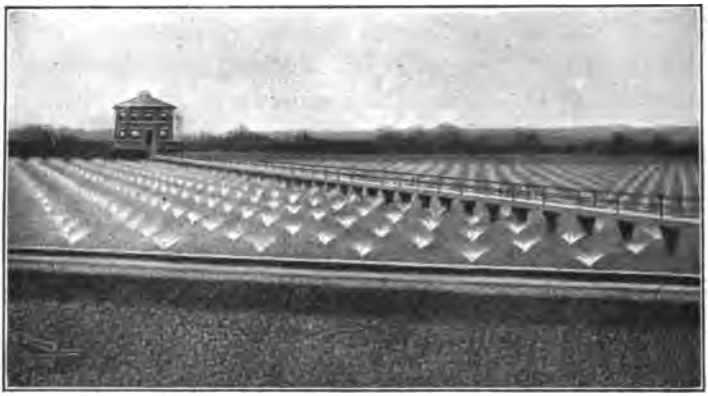

Fig. 129.—A trickling filter for the purification of city sewage, at Columbus, Ohio.

settle in tanks. Sometimes it is necessary to go farther and to purify the sewage by passing it through filters of sand or stone.

These sewage filters are not intended to strain out bacteria (like the water filters described above) but to secure chemical changes in the organic matter of the sewage, so that it will not decay and produce bad smells. The filters in this case are really places where the useful kind of bacteria that destroy sewage matter can live and get a good chance to do their work. Such bacteria grow on the stones

or sand grains of the filter in a jellylike mass. Plenty of air is supplied for their use, either by letting the sewage run on to the filter in small quantities at a time, or by making the filter so open that air can get freely through it. For instance, the filter shown in Fig. 129 is a bed of rough stones about two inches in diameter. The sewage is sprayed up into the air from little fountains all over the bed, and as it trickles down through the bed, the bacteria on the surface of the stones feed upon it and purify it.

Disposal of Garbage and Refuse.—Besides the liquid wastes of the city which flow away in the sewers, there are solid wastes which must somehow be disposed of. There is the garbage or kitchen waste, the ash from fires of all sorts, and the rubbish, such as waste paper, sticks, tin cans, and bottles. The employees of the city, or of some private contractor engaged by the city, should come at regular and frequent intervals to carry these things away. Garbage, especially, decays and becomes offensive, if it is not promptly removed.

Fig. 130.—The covered garbage pail.

The carts in which garbage is carried through the streets should be of metal so that they can be kept clean, and should have tight-fitting covers so that they may not be offensive

as they pass. The ash and rubbish carts should be covered sufficiently to keep the ashes and papers from blowing about.

In small communities, the refuse may be dumped into some low open place, and the garbage may be taken to farms and fed to pigs. Refuse dumps are always likely, however, to be a nuisance. They smell bad and breed flies; dust blows from them, and they are often the sources of dangerous fires.

In large cities, there must generally be some definite way of disposing of refuse. The clean ashes may be used for filling low areas. The rubbish may be sorted, and the papers and cans sold to manufacturers. The garbage may be treated in a so-called **reduction plant,** where the grease and fertilizing substance which it contains are extracted and sold. Another way is to burn all the solid wastes together in a special kind of furnace called an **incinerator.**

Keeping the City Clean.—Dirty streets and dirty backyards are unsightly, and contribute indirectly to ill-health. Accumulations of organic filth breed flies, and flies may carry disease. We judge people largely by the conditions of their home; if the house is dirty and untidy, we think that it is not a pleasant place to be in, and that the family is slovenly. It is just so with a town; and we all want our town or city to be one that we may be proud of.

A good citizen will help the city government to keep the streets clean, by never scattering papers, banana skins, or other refuse. In many places, the young people of the town have formed themselves into a civic militia, and as Boy Scouts or School Sanitary Squads have done splendid service in keeping their neighborhoods clean and orderly.

There is one man of whom we always like to think, in

connection with this problem of municipal cleanness, Colonel George E. Waring (1833–1898). The election of 1894 in New York City turned very largely on the dirty condition into which the city government had allowed the

Fig. 131.—George E. Waring (1833–1898), the man who cleaned the City of New York.

streets to fall. The new administration asked Colonel Waring to reform the whole business of street cleaning. His men were called Waring's White Wings, because they were dressed in white washable suits; and they did their work so thoroughly, under the system he worked out, that

his reputation became world-wide as "the man who cleaned New York." When the United States took possession of Cuba in 1898, Colonel Waring was sent to clean up Havana, and he did it with the same success.

Questions for Discussion and Review

1. Which do you think is more important in a community, the water supply or the sewerage system?

2. Show by an example why it is necessary to have general laws of sanitation in a community rather than to trust to the hygienic habits of single families.

3. Where does water come from primarily? Trace the history of the glass of water that you drank at breakfast, from its source to your glass.

4. What are surface supplies? Ground water supplies? Under which head would you class a lake? A river? A well?

5. By what different means is water forced into our houses?

6. How may water become polluted?

7. What three ways have engineers and chemists found to purify water? Explain each of the three.

8. If you live in a city or town where there is a public water supply, find out where the supply comes from and what steps are taken to make it safe. If you live in the country, where water is supplied by wells, study the well at home or on the school property, its location with reference to the closet or cesspool and other sources of pollution, and the means taken for protecting it from surface wash.

9. Why is there nowadays often more danger from water in the country than in the city?

10. Why is hard water considered undesirable? How is it sometimes changed?

11. What dangers are there in emptying sewers into a river or lake?

12. Cite an instance in which typhoid fever was carried to several towns through discharge of sewage into a river.

13. Under what conditions may sewage be emptied into a river or lake with safety?

14. What happens when sewage is discharged into a large body of water? Into a small one?

15. Explain the method of sewage filtration.

16. What advantages are there in having a clean city? Which do you think is better, to clean up a little every day or to have periodical Clean-up Days?

17. How are household wastes and refuse disposed of in your town?

18. How can boys and girls help the paid street cleaner? Have you cans for waste papers on the street corners in your town? Do you use them?

19. Who was Colonel Waring and what did he do?

CHAPTER XXIX

THE HEALTH BOARD AND ITS WORK

The Work of the Board of Health.—We have seen in earlier chapters that the various communicable diseases may be controlled, if proper steps are taken to prevent their spread. Good sanitary regulations, and their vigorous enforcement, are necessary in order that this may be accomplished. The food that comes into the city or town, and the stores where it is handled and sold, must be inspected. The homes and factories where people live and work, and the streets, yards, and open places must be supervised to see that there are no conditions likely to cause disease. The public must be educated as to the causes of disease and taught how diseases of all kinds may be avoided. The statistics of births, deaths, and cases of communicable disease must be carefully kept and analyzed, so that the whole public health campaign may be properly directed. These things are the duties of the Board of Health of the city or town, and of the state, and of the United States Public Health Service at Washington.

The Control of Communicable Diseases.—All cases of communicable disease should be promptly reported, so that the Board of Health may send an inspector to see that the case is properly isolated during its course, and that the necessary cleansing or disinfection is carried out afterward.

In diphtheria, it is the business of the health authorities to see that the sick person and carriers in the family are given antitoxin; and in smallpox and typhoid fever, they

must see that all persons who have been exposed are protected by vaccination.

Whenever there is an increase in the number of cases of any disease, the Board of Health attempts to discover the cause and takes the necessary steps to prevent the further spread of the germs, by purifying water or milk, by isolating

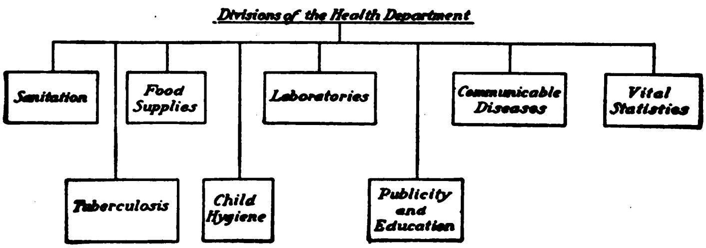

Fig. 132.—Organization of the Health Department. Above, the five principal divisions, and below, the three divisions which are organized separately only in the larger cities.

infected individuals, by destroying insect carriers, or by whatever other measures are required. When a serious epidemic occurs, such as the influenza epidemic of 1918, the Board of Health may decrease the opportunities of infection by closing schools, churches, and places of public assembly.

The Health Laboratory.—In order to carry on its work, the Board of Health must have not only trained medical experts, but also a properly equipped laboratory.

In this laboratory, samples from the throat and samples of blood and other body fluids are examined to see whether suspected cases are really diphtheria, tuberculosis, malaria, typhoid fever, or whatever the disease may be. In the four diseases mentioned, and in many more, the bacteriologist, with his microscope and growths or cultures of bacteria, is the one to give final judgment as to the nature of

a doubtful case. Diphtheria and typhoid carriers can be detected only in this way—by the fact that the bacteriologist actually finds the disease germs in throat or discharges. In diphtheria, the end of the isolation period is

Fig. 133.—A Board of Health laboratory.

usually fixed by the disappearance of diphtheria germs from the throat, as shown by laboratory tests.

In the larger city and state laboratories, various sera and vaccines are prepared for free distribution to the public. Diphtheria antitoxin, and smallpox and typhoid vaccines, with other preparations of the same sort, should be available for all, whether they are able to pay or not. The purity of these preparations should, moreover, be guaranteed by the Board of Health.

It is also the duty of the Board of Health laboratory to examine samples of water, milk, foods, and drugs, so as to

determine their quality by chemical and bacteriological tests.

Supervision of Food Supplies.—The Board of Health must assure itself by inspections, as well as by laboratory examinations, of the purity of the public water supply and of the milk and food supplies of the city or town.

Its representatives inspect the land near the river, lake, or reservoir from which the water supply comes, to make sure that there is no danger of pollution by sewage. They watch the operation of the filter or disinfecting plant by which the public water supply is purified, and see that it works efficiently.

Another of their duties is the inspection of the dairies which supply milk, to see that the stables and milk houses are clean, that the cows and milkers are healthy, and that the milk is properly iced and cared for in transportation to the city. The inspectors carefully oversee the working of the pasteurizing plants, to make sure that all the milk is really heated as it should be.

The representatives of the Board of Health inspect the stores, restaurants, and other places where food is handled, and assure themselves that conditions are cleanly, and that sick people are not employed in the preparation of the food. They inspect the food itself to see that no infected or spoiled food of any kind is sold, not only because it is unhealthful to eat such food, but because no dealer has the right to take people's money for food that is not clean and wholesome.

In many cities and states, the Boards of Health also attend to the detection of food and drug frauds—adulteration, the use of misleading labels on foods, and the use of preservatives which may be injurious to health. It is particularly important that medicines should be of

the right strength, for if they are too weak they will not give the effect the doctor wants, or if too strong they may do serious harm. The examination of foods for fraud is chiefly important to protect the pocketbook of the consumer and enable him, when purchasing food, to get as good quality as he pays for.

Inspection of General Sanitary Conditions.—Another group of inspectors deals with the general sanitation of the city or town, with the conditions which may breed disease, or which create offensive nuisances.

Much of the work of these sanitary inspectors has to do with the prevention of bad smells, from glue factories and other offensive industries, with the cleaning up of dirty backyards, and with the removal of conditions that are objectionable to the eye or to the nose.

The most important activities of the sanitary inspectors are those which deal with the disposal of human wastes and with conditions that favor the breeding of insect carriers of disease. Carelessly-built outside toilets, overflowing cesspools, and open drains are very real dangers, and whatever is done to remedy these conditions is an aid to public health. The treatment of mosquito-breeding pools, and the removal of filth in which flies may breed, may also directly and effectively prevent disease.

The inspection of tenements to see that there is light and air for those who live in them, that fire escapes are provided and are kept clear, that toilet facilities are adequate, and that the building is decent and clean; the inspection of factories to see that machinery is safe, that the workers are protected against harmful dusts and poisons used in their work, and that the workrooms are properly ventilated and lighted—these are special types of inspection which must be

carried out by some public authority. Sometimes they are under the care of the Board of Health, but more often, perhaps, there is a special department created for these purposes, such as a Tenement House Department or a Bureau of Labor.

Educational Activities of the Board of Health.—Probably the two most important health problems are infant mortality and tuberculosis. In dealing with these questions and with many others, the Board of Health must use educational methods rather than legal force.

We have seen in preceding chapters that tuberculosis can best be controlled by teaching people how to live healthy lives, so as to build up their vital resistance, and that infant mortality must be controlled chiefly by teaching mothers how to care for their babies. So the Board of Health provides clinics and dispensaries, where medical advice and treatment can be given to those suffering from tuberculosis, and sends nurses into the homes to find the early cases and to teach how to check the progress of the disease. It supports the Infant Welfare Stations, where the mothers may bring their babies to get instruction as to feeding and care.

In many fields of work, the health authorities need the help of the individual citizen. Progressive health departments, therefore, publish monthly or weekly bulletins, besides special circulars of information for the public. They supply the newspapers with carefully prepared news of the latest discoveries, and of the facts people ought to know in order to keep themselves and their families well. They prepare exhibits for the public, and send out lecturers to speak at schools and churches, and before various clubs and civic organizations.

Health workers will not be satisfied until the whole community is organized into a great united army for the prevention of preventable disease.

The Public Health Nurse.—One of the most recent and most important of the activities of the Board of Health is

Fig. 134.—The public health nurse explaining health laws to the mother.

the employment of public health nurses, not to take care of the sick but to help people to keep well by teaching them the principles of hygiene.

The first person to see what a future there was for such *health nursing* was the great Englishwoman, Florence Nightingale (1820–1910). It is said that, when a child, her

favorite game was to bandage and nurse her dolls, and that her first living patient was an injured shepherd dog. When she grew up, she kept her love of animals and combined it with a passion for helping suffering men and women. She became a pioneer in organizing hospitals and in developing the work of nursing. Then came the Crimean War in 1854–1855. There was no proper preparation for caring for the wounded at the front. Florence Nightingale was called upon for help and went out to the Crimea, where she soon had 10,000 men in the hospitals under her care. She organized these hospitals so successfully that the death rate was cut to one twentieth part of what it was before.

Fig. 135.—Florence Nightingale (1820–1910), founder of the profession of health nursing.

Florence Nightingale thought of nursing as including much more than the sick nursing done in a hospital. She saw, as few people did in those days, that fresh air, light, warmth, cleanliness, quiet, and diet were the chief factors in keeping health, as well as in recovering from sickness. After the war was over, she urged, at every opportunity, the value of health nursing, or education by nurses in the principles of hygiene. The Infant Welfare nurse, the school nurse, and the tuberculosis nurse

are employed by the Board of Health to-day largely as an indirect result of the teachings of Florence Nightingale.

Results of the Public Health Campaign.—The campaign against preventable disease really began only after the discoveries as to the relations between microbes and disease, made by Pasteur and his followers between 1880 and 1890.

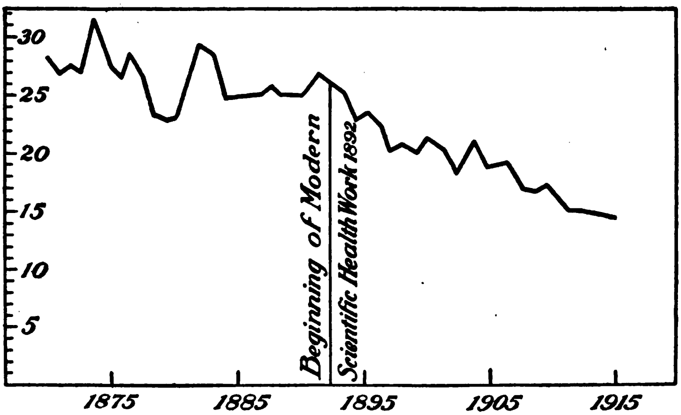

Fig. 136.—Results of the Public Health Campaign in New York City.

The curve shows how the death rate of New York City fell from between 25 and 30 deaths per 1000 population between 1870 and 1880 to less than 15 per 1000 in 1915. By 1920 the rate was reduced to 13 per 1000. The principal reduction has been since 1892, when active modern public health work began.

Since then, the results obtained have given proof of the value and importance of progressive sanitary measures.

The success of public health work in any community is measured by its **vital statistics,** or the records of deaths and cases of disease, from various causes and at different ages, compared with the actual population. In this book we can consider only the simplest of all methods of measuring sanitary conditions—the general death rate.

The general death rate is the ratio of the total number of deaths from all causes in a year to the number of people in the city, town, or state, reduced to a basis of 1000. For instance, if in a city of 10,000 people there are 150 deaths in a given year, the general death rate would be 15 per 1000.

Fig. 136 shows what has happened to the general death rate in New York City since 1870. The death rate fell from 26 in 1888 to 14 in 1913, or, in other words, decreased by 46 per cent in twenty-five years. There are to-day about 200 deaths every twenty-four hours in New York City. If the death rate of twenty-five years ago had continued, there would be 370. Similar reductions in the death rate have followed in many other cities and states where vigorous campaigns have been made against preventable disease.

The health departments of New York City and of New York State have taken as their motto the statement:

Public health is purchasable. Within natural limitations, a community can determine its own death rate.

It is a bold saying but a true one. If you remember it as you grow up, you will do all you can to make your city and your state secure a low death rate by setting in operation all the machinery necessary for the prevention of preventable disease.

Questions for Discussion and Review

1. What are some of the matters which come under the control of the Board of Health?

2. How is the spread of communicable diseases prevented? What is the duty of the Board of Health when a case of communicable disease is reported?

3. If a man were quarantined for a light attack of some disease, and decided to go out to business before the danger of

infection was over, would he be a good citizen? Could he be punished?

4. Where there is doubt as to whether a patient has diphtheria or only a sore throat, what does the Board of Health do in order to find out the truth?

5. In a case of diphtheria, what precautions are taken with those who have been exposed? In typhoid fever? How is the isolation period for diphtheria determined?

6. Why is it considered necessary to inspect all food supplies?

7. How does the Board of Health supervise the water supply? The milk supply?

8. Why is it necessary to examine the milkers in dairies, as well as the cows? Why does the Board of Health oversee pasteurizing plants?

9. The Sanitary Code of New York City requires that all foods exposed for sale must be covered. Why?

10. There has been a movement requiring medical inspection of cooks in restaurants. Explain.

11. What would be the work of a government inspector in each of the following departments: (a) factory inspection, (b) tenement inspection, (c) general sanitary inspection?

12. What did we find was the advantage in educating the public in the care and prevention of tuberculosis?

13. How is the method of educating the public used to save the lives of babies?

14. How does the visiting nurse help in carrying out this work?

15. Have you a nurse in your school? What are her duties?

16. Who was Florence Nightingale and why is she famous?

17. Which is the finer kind of work, the nursing of the sick or the prevention of sickness? Defend your opinion.

18. Why is the work of the Board of Health much more effective now than it was before the days of Pasteur?

19. How is the success of public health work measured?

20. What is meant by the general death rate? Why has the death rate fallen in the past twenty-five years?

21. Find out the death rate in your city or town. Is it a low rate?

22. What is the health motto of New York City? Do you believe in it? What can each person do to help make it true?

CHAPTER XXX

ACCIDENTS AND FIRST AID

What to Do When Some One is Hurt.—The two things to remember when some one is badly hurt are to keep cool and to send for the doctor. Often, however, before the doctor arrives, there are simple measures that may be taken to lessen the pain and perhaps prevent serious harm. Some of these simple first aids every one should know, so as to be able to do the right thing when the need arises. In bad accidents, prompt action of this kind may sometimes save a life.

Foreign Bodies in the Eye, Ear, Nose, and Throat.—One of the commonest of the lesser accidents is getting a sharp bit of dust or cinder into the eye. When this happens, the eye should not be rubbed, for rubbing only makes matters worse. If the particle can be seen on the eyeball, it may be removed with the corner of a clean, soft handkerchief. A speck on the lower lid often becomes visible, so that it may be removed, if the lid is pulled down with the finger. Some times, if the eye is kept closed for a few minutes, the tears, which flow whenever the eye is hurt, will wash the speck out where it may be seen and removed. Blowing the nose may also help. Sometimes a particle on the upper lid may be removed by taking hold of the lashes of the upper lid, and pulling it down over the edge of the lower lid two or three times, while the patient looks downward. If this does not dislodge the speck, it must be looked for on the upper lid by taking hold of the eyelashes and rolling the

eyelid back over some small object, such as the small end of a penholder. The speck may then often be seen clinging to the under side of the lid. (See Fig. 137.) If the object cannot be removed in this way, a doctor should be consulted, for a sharp particle may in time work in and do serious harm.

Fig. 137.—How to find a foreign body on the upper eyelid.

If anything gets into the ear, it is safest to send for the doctor at once, as an attempt to remove anything from the ear with pointed objects may be dangerous. In the case of a live insect in the ear, a few drops of castor oil or sweet oil may be dropped in; this will usually wash the insect out.

If anything sticks in a person's throat, nothing should be done until the doctor comes, unless the object can be seen on looking into the throat. If it can be seen and is not too firmly wedged in, it may be possible to remove the object. If the patient is trying to cough out the obstruction, it sometimes helps to slap him on the back while he bends his body forward.

Nosebleed.—Nosebleed may be due to some slight injury, or, as often happens with children, it may come on without any injury at all. It is usually not serious. Slight nosebleed does not require any treatment, but if it continues, the patient should be put in a chair with his head hanging back and his collar loosened, and a cloth wrung out in cold

water should be placed at the back of the neck. A plug of cotton inserted into the nostril affected will help to retard bleeding, and pinching the soft part of the nose is also effective in some cases.

Cuts and Wounds.—The principal danger in a wound is that it may become infected with bacteria. In very serious cases, there is danger from the loss of blood. In most wounds, however, bleeding is a good thing, because it tends to wash out dirt and germs.

Slight cuts and scratches should be washed free from dirt, then dried with clean gauze, and painted with tincture of iodine. More serious wounds should be dressed temporarily, until the doctor can attend to them, by covering them with surgeons' gauze fastened on with a bandage. A doctor should be consulted about even the slightest scratch if, after a few days, it is red, hot, or painful; and a deep wound, particularly if produced by a rusty nail or other dirty object, should always receive prompt medical attention. Any wound will heal without much pain or redness if there are no germs in it. Remember that germs get into a wound, not from the air, but from dirty things that touch it. A scratch or cut should never be touched with anything but sterilized surgeons' gauze, and above all should never be picked with the fingers. In connection with automobile accidents, remember that gasoline is a good disinfectant.

If the blood comes from a wound in jets or spurts, an artery is bleeding, and the result may be serious if the flow is not checked. Fortunately, at most parts of the body the arteries are deeply buried in the flesh. A severed artery calls for prompt action. Put firm pressure close to the bleeding part, between the wound and the heart. In case the wound is in the arm or the leg, the pressure is best

applied by tying a knot in the center of a folded handkerchief, and laying this knot over the artery. Tie it loosely around the limb, but with a good knot. Place a stick under the bandage and twist it round and round until

Fig. 138.—Tying a bandage on an arm to check bleeding.

the bandage is tight enough to stop the bleeding. After five or ten minutes the bandage should be slightly loosened to see if the bleeding has stopped. If not, tighten the bandage again. If the bleeding is checked, leave the bandage ready to tighten at the first sign of further bleeding. A bandage that is too tight or is kept tightened too long may cause serious trouble. The wound should, of course, be cared for by a doctor immediately.

Bruises and Sprains.—The pain and swelling of an ordinary bruise will be much less, if something cold is placed on the bruise at once to drive the blood away. Ice in a cloth may be used, or simply a cloth wrung out in cold water.

If a joint has been *sprained* (which means that the liga-

ments that hold the bones together have been strained or torn), the same treatment with cold cloths is very useful, and should be kept up at intervals for twelve hours. In old and enfeebled patients, hot wet cloths are better. The injured part should be placed as high as possible, so as to keep the blood out of it. One should never walk with a sprained knee or ankle unless the doctor advises it, as pressure may do harm. Sprains are often troublesome, and if a sprain is at all bad, the doctor should be sent for.

Broken Bones.—If a bone is broken, medical care is, of course, necessary. While waiting for the doctor, the only thing to do is to keep the broken limb in as comfortable a position as possible. *Do not let the limb bend* at the place where the bone is broken, because that gets the splinters of bone out of place, and may drive them through the skin and lead to an infected wound. If you find it necessary to lift a broken limb, put one hand on each side of the break and lift with both hands at the same time.

Fainting.—Fainting, or growing dizzy and losing consciousness, is caused by a temporary failure of the circulation to send enough blood to the brain to keep it acting. People may faint from many causes, most of which, in the case of young people, do not indicate anything particularly serious. Fainting is often caused by the hot, stuffy air of a badly ventilated room. The two things to be done for a person who has fainted are to get him into a horizontal position so that the blood may go back to his head, and to cool off the skin, which tends to send the blood inward.

The person should, therefore, be placed in a current of air (outdoors, if possible) and laid on his back with his head flat, either on the ground or on a couch without a pillow. The clothing around the neck should be loosened.

It often helps to sprinkle a little water over the face. Nothing should ever be poured down the throat of an unconscious person, except by a physician, as such an attempt by one who is unskilled may lead to choking.

Sunstroke and Heat Prostration.—A person who has become faint and dizzy from the direct effect of strong sunlight shining on the head, should be placed in a seated position in the shade. His clothing should be loosened, and cold water poured on his head, or his body rubbed with bits of ice. Cool drinks should be given, if possible.

Heat prostration due to excessive heat acting on the whole body, and not to the direct sun's rays, should be treated somewhat differently, on account of the fact that in such a case the blood vessels all over the surface of the body will be dilated. The patient should be laid flat on his back in a cool place, his clothing loosened, and his hands and feet rubbed to restore the circulation. The face and body should be bathed in *warm* water and *warm* drinks should be given.

Burning Clothing and the Treatment of Burns.—If the clothing catches fire, there is only one thing to do and it must be done quickly: *smother the flame*. Fire needs plenty of oxygen, and if a person whose clothing is on fire is quickly and closely wrapped in a coat, shawl, blanket, or rug, the fire will go out. It is important to remember to wrap the cloth *from above down*. If the wrapping is done from below, the flames may be driven up and inhaled into the lungs with very serious results.

If your clothing catches fire when you are alone, do not run for help, but lie down flat and roll over and over on the floor or on the ground, to smother the flames.

In the case of a slight burn which only reddens the skin

without forming a blister, the pain will be lessened if the air is kept from the burned place. A paste of ordinary baking soda and water applied to the burn will do this, or carbolized vaseline or any grease, like lard, may be used instead. The burn should then be covered by tying a piece of cloth or bandage around it. If there is extensive blistering, the application of soda or vaseline may do harm; and severe burns should be treated like the open wounds discussed on page 344.

Frostbite.—If ears, nose, or fingers are frostbitten, the affected part should be rubbed with snow or very cold water until the blood has come back and the flesh begins to sting and burn. On no account should the person go into a warm room until this has been done, and until the frozen part has been gradually warmed by rubbing. Even after the circulation has come back, the patient should not be brought into a very warm place too soon.

Drowning and Suffocation.—When a person has been under water or in some suffocating gas for a long time, the breathing stops, and the patient becomes unconscious. If breathing can somehow be started again, recovery may follow. The starting of the breathing movements in a person who has ceased to make them for himself is called **artificial respiration.**

Artificial respiration should be begun by laying the patient face downward upon the ground. The feet should be raised to drain out any excess water from the air passages. Stretch the arms of the patient straight above his head and let them rest on the ground in that position. Turn his head a little to one side so that the air will not be impeded in entering the nose and mouth. Next stand astride of the patient, with your body directly over his hips and facing his

head. Put your hands on each side of his back, below the shoulder blades. Your hands now rest upon the patient's lower ribs. The fingers are spread out, pointed toward the head and away from the spine.

Swing your body forward, keeping your arms straight and allowing your weight to rest on the patient's back; then swing back, taking all your weight off the patient. Do this fourteen to sixteen times per minute, to imitate the motions of breathing. When you put your weight on the patient, you press his chest together and force the air from the lungs; when you release the pressure, the chest springs back into place, and the lungs expand and draw air into them.

Recovery may be very slow; keep up your work for at least two hours. While this process is going on, the patient's clothing should be removed. If necessary, he should be dried with a towel and then covered with a blanket. This work must not interfere with the operator who is carrying out the artificial respiration. Compel bystanders to stand back. The patient needs every bit of air he can get.

When the patient begins to breathe,—but not before,—he should have his legs and arms rubbed *toward* the body. This should be done without removing the blanket. The patient will not breathe well all at once, and it will be necessary to help him at first by continuing the artificial respiration every little while. Of course, if breathing stops at any time, the artificial respiration must be renewed.

After the patient is breathing well, put him to bed. Surround him with hot water bottles and cover him up well. As soon as he can swallow, give some hot coffee. Open the windows wide, and allow him to sleep quietly.

Electric Shock.—Cases of electric shock (from contact with live wires, for example) and cases of gas poisoning re-

quire the same treatment as drowning—artificial respiration—since the stoppage of respiration is the chief danger to be feared.

The first thing to do in a case of electric shock, however, is to rescue the person from the action of the electric current, since the danger increases greatly with the length of exposure. If the current can be shut off, this is, of course, the simplest procedure. A live wire may be flipped off the patient with a dry board or stick, or it may be cut with an ax or hatchet with a dry wooden handle. Dry wood is essential, because water is a good conductor of electricity and wet wood or metal would transfer the current to the rescuer.

If the injured person is to be removed from the wire, the greatest care must be taken to avoid the discharge of the current from the wire or from the body of the victim to that of the rescuer. In order to guard against this, the hands should be covered with a rubber cloth or with several thicknesses of ordinary dry cloth; silk is a good non-conductor. If possible, the rescuer should stand on a dry board or a thick piece of dry paper, or even a dry coat. The separation of the wire from the patient should be made with one motion, because rocking to and fro on the wire will increase shock and burn.

Poisons.—If some poisonous drug has been taken, the first thing to do is usually to get it out of the body again as quickly as possible by causing vomiting. This may be done by running the finger down the throat, by drinking a large quantity of warm water, or by taking some substance which will cause vomiting, called an **emetic**. A teaspoonful of mustard or salt in a glass of lukewarm water will serve as an emetic. Promptness is more important than an exact

dose. After the emetic has been taken, large quantities of warm water should be drunk, to dilute the poison that remains.

In the case of strongly corrosive poisons, such as strong acids (sulphuric, hydrochloric, nitric) and strong alkalies (caustic soda, potash, and lime), an emetic should not be given, but something should be used which will neutralize the poison. Plaster from the ceiling, magnesia, baking powder, or even soap may be used for this purpose, with acid poisons; and vinegar, lemon juice, or orange juice, with alkalies. To dilute such poisons and soothe the tissues, there should then be given large quantities of oil, such as olive, salad, sardine, castor, or cod liver oil, or milk and eggs beaten up. Finally, stimulants should be given, such as strong tea or coffee, ammonia, or alcohol.

Carbolic acid, or phenol, acts in a different way from the strong mineral acids, and the antidotes used for them will not serve in the case of this poison. The effective antidote for carbolic acid is alcohol. It should be used as follows:

For an infant under one year of age, ½ ounce alcohol in 2–3 ounces of water.

For a child from one to seven years, 1–2 ounces to 3–4 ounces of water.

For a child from seven to sixteen years, 3–4 ounces of alcohol to 4–5 ounces of water.

For a person over sixteen, 4 ounces of alcohol to 4 ounces of water.

Immediately after the dose of alcohol, a tablespoonful of mustard in 6–7 ounces of water should be given as an emetic; and the dose of alcohol, followed by the emetic, should be repeated three or four times, or even six or seven times if the poisoning has been severe. After this treatment,

Glauber's or Epsom salts should be given (2 teaspoonfuls to 2 tablespoonfuls in 4–8 ounces of water, according to age) followed by milk, white of egg, or thick gruel, to soothe the mucous membranes.

For poisons that are irritant but not corrosive, such as tartar emetic, blue stone, Paris Green, lead, corrosive sublimate, and arsenic, an emetic should be given, followed by water and then by oils or milk and eggs, as above, and by stimulants.

For nerve poisons which produce sleep or nervous convulsions, such as opium, morphine, laudanum, paregoric, and soothing sirups, an emetic should be given promptly. If the patient is sleepy, every effort should be made to keep him awake by giving him strong coffee, shaking him, and slapping him with a wet towel. Artificial respiration may be necessary.

Ivy Poisoning.—Some people are very sensitive to ivy poisoning, while others may come in contact with the plants without suffering at all.

Ivy poison is in the form of tiny drops of oil, and if the first places affected are scratched, the infection may easily be carried to other parts of the body. One should, therefore, avoid scratching. The itching parts may be soothed by a cloth moistened with alcohol, or washed off with a boracic acid solution, then dried gently and treated with carbolized vaseline. If the skin is washed thoroughly with soap and hot water after exposure to ivy poisoning, the danger from poisoning is often lessened.

Snake Bites and Insect Stings.—Most of the snakes found in the United States are harmless, but there are three—the rattlesnake, the copperhead, and the water moccasin—which are very poisonous. If a person is bitten

by one of these snakes, a handkerchief should be tied between the bitten part and the heart, and twisted tight by means of a stick, so as to compress the blood vessels and prevent the poison from being carried to the rest of the body. Then as much as possible of the poison should be sucked out of the wound. This may be done with safety,

Fig. 139.—Foliage of the poison ivy.

as the poison will not injure the mouth if it is spit out at once, unless one has cuts or scratches in the mouth.

The stings of insects found in temperate climates rarely do any harm unless disease germs of some sort are carried with them. The pain of a bee sting may be relieved by applying some alkali, like soda or ammonia, and, to a considerable extent, by merely plastering a little wet mud on the place bitten.

Questions for Discussion and Review

1. Why should every one try to keep calm after an accident? Why should a doctor be sent for at once?

2. What danger is there in allowing a foreign substance to stay in the eye?

3. What is the best way to pick a particle of dust out of the eye, when it can be readily seen?

4. If anything lodges in the ear, is it safe to poke after it with a pin, hairpin, or other sharp-pointed instrument? Explain.

5. What treatment may be given for nosebleed?

6. Why is it a good plan to cleanse and disinfect even the smallest scratch? What danger is there in scratches and "skinning" which does not exist in bruises?

7. In a Fourth of July accident, a boy's leg was badly torn by an explosion, and pieces of his stocking were carried into the wound. Was there danger of infection? Explain.

8. Give an example of an accident in which the use of a bandage would be necessary.

9. On a hike, a boy stepped into a hidden hole and turned his ankle. It began to swell at once. What would you have done for him? Should he have walked home, even if he could stand his weight on the ankle? Explain.

10. Find out what splints are. Why are they used in case of a broken bone?

11. If a person broke his leg when he was at some distance from medical aid, what would you do for his temporary relief? What means could you devise to carry him, without injuring the broken leg further?

12. What causes fainting? Under what conditions might you expect to have accidents of this kind? How would you revive a fainting person?

13. In case of fainting or accident, there is a tendency for crowds to gather. Why should this not be allowed?

14. What is fire? Why do things burn? What do we do when we smother a flame?

15. In wrapping a coat or rug around a person whose clothes are on fire, why should we begin at the top?

16. If your clothes were on fire, why should you not run for help?

17. Two boys had their ears frosted while skating. One of them rubbed snow on his ears and the other went into the house to thaw out at the stove. Which probably had the more painful time? Why?

18. What do we mean by drowning? In what way does drowning differ from suffocation by gas?

19. Explain in detail the method of artificial respiration. Illustrate with one of your fellow students.

20. Why do you repeat the process at the rate of sixteen motions per minute? How long would you continue the process before giving up hope?

21. Why should the patient be dried and covered with a blanket? Should this be done before the artificial respiration is started?

22. In what other accidents do we use artificial respiration?

23. What is a poison? What is meant by corrosive poisons? Irritant poisons? Nerve poisons? Explain what you would do for each and why.

24. Is ivy poisoning common? How should it be treated?

25. What danger is there in snake and insect bites? How are they treated?

CHAPTER XXXI

SAFETY FIRST

Safety First.—Wherever one goes nowadays, one may see the signs SAFETY FIRST—on railroad crossings, street cars, bridges, and wharves, and on the walls of machine shops and manufacturing plants.

These signs are not put up by people who think that safety should always be the first concern. Nobody believes, of course, that personal safety should stand in the way of any one's doing whatever may be necessary to preserve the lives and well-being of others, or that it should keep any one from risking even his life for what he thinks is right. But a great many times lives are lost unnecessarily, by reason of carelessness or negligence.

SAFETY FIRST ought to teach three things. First, that lives should not be risked foolishly. Second, that in the running of great industries such as machine shops, railroads, or factories, safety is of more importance than economy or quickness, and that it is the duty of those who are responsible for the lives of others to take all possible precautions to ensure their safety. Third, that these precautions should be taken *first*, that is, before serious or fatal accidents have occurred.

You have all heard the saying about locking the barn door after the horse has been stolen. It is a very good thing to know the principles of First Aid, so that when emergencies occur, one may be able to deal with them. But it is far more important and far wiser to form habits

of avoiding dangers, in order that the emergencies may never occur.

The "Rules for Prevention of Accidents" prepared by the National Council of Boy Scouts of America in coöperation with the National Safety Council[1] begin with the following striking indictment of carelessness.

Carelessness

More powerful than the combined armies of the universe.
More destructive than all the wars of the world.
More deadly than the mightiest of siege guns.
Relentless everywhere: in the home, on the street, in the school and factory, at railroad crossings, on the sea.
Lurking in unseen places, working silently.
Scattering sickness, degradation, and death.
Sparing none; rich or poor; young or old; strong or weak.
Massacring thousands upon thousands of children and wage earners each year.
Wasting over $300,000,000 annually in the United States.

Safety in the Home.—"Safety begins at home."

Pick up pins and needles; they cause the death of many babies.

Be on the lookout for sharp knives, scissors, etc., and see that they are kept out of the reach of small children.

Keep medicines out of the reach of small children.

Do not leave anything on the stairs that may cause people to slip, trip, or fall.

Keep rugs and carpets flat so that people will not trip over them.

[1] From the "Rules for Prevention of Accidents" many of the suggestions in this chapter have been taken, and to them the indebtedness of the author is gratefully expressed.

Keep the yard free from broken glass, rusty wires, and projecting nails.

Safety from Fires.—Great numbers of lives and millions of dollars' worth of property are lost each year as a result of fires, many of which are due to common acts of carelessness. If you are a Boy Scout or a Campfire Girl, or if you believe in SAFETY FIRST, you will do everything in

Fig. 140.—Boy Scouts at work cleaning up a city.

your power to prevent people from doing the careless things that may lead to fires. Among these things are:

Leaving combustible rubbish in cellars or attics or near buildings.

Leaving oily rags lying about loose or in wooden receptacles.

Placing paper, cotton, or other flimsy materials near lights.

Failing to fasten back any lace curtains which are near gas brackets.

Hanging clothing near the stove or stovepipe.

Leaving matches where children can reach them.
Using any kind of matches except safety matches.
Using rubber connections for gas stoves.
Filling oil stoves or lamps when they are lighted or near other lights.
Kindling fires in stoves with kerosene or gasoline.
Using benzine or gasoline for cleansing in a closed room, or near a flame or a hot flatiron.
Putting hot ashes into wooden receptacles.
Using lighted candles on Christmas trees.
Throwing away lighted matches, cigars, or cigarettes.
Lighting matches in closets or attics where clothes are hung.
Lighting matches in a room where gas is escaping.
Firing pistols, firecrackers, or fireworks near inflammable material.
Making bonfires near buildings.
Burning leaves or rubbish on a windy day.
Letting children make bonfires or play with fire.

If you are ever in a school or theater or other public place when a cry of fire is started, *keep cool*. Do not scream or try to be the first one out of the building. Your life and the lives of others may depend upon your keeping your head. Often more damage is caused by panic than by the actual fire.

Every child should learn how to send in a fire alarm, and should know the location of the fire alarms in the neighborhood.

When you hear a fire alarm, keep on the sidewalk.

Safety in the Street.—The street of a modern city, town, or even a country village, is no place to play in and no place to walk in carelessly or thoughtlessly. The automobile and the electric car are among the most useful servants of man-

kind, but they claim thousands of victims every year, and will continue to do so as long as drivers, passengers, and pedestrians are careless.

If you believe in SAFETY FIRST:

Keep to the right in walking and in entering doorways.

Don't cross crowded city streets in the middle of the block or diagonally; use the cross walks at the intersection of the streets.

Don't run across the street in front of a car, wagon, automobile, or motorcycle, or just behind a vehicle (which may hide something coming in the opposite direction). It is better to be late for an appointment than to be carried to the hospital.

Don't play in the street where cars, automobiles, motorcycles, and wagons must run. Find playgrounds or open lots where play is safe.

Don't steal rides on cars, wagons, or automobiles.

Don't skate on roller skates in the street. Accidents due to hitching on wagons with roller skates are very common.

Coast in an open field, not across a much-traveled highway or across car tracks.

Don't touch any parts of automobiles that are standing in the street.

When waiting for a car, stand on the curb, not in the street.

Don't get on or off a car while it is moving. When you do get off, always face toward the front. Get *on* with the right hand and the left foot, get *off* with the left hand and the right foot.

Don't stand on the crowded step of a car. A sudden jerk or jolt may knock you off.

Don't put your head or arm out of the open window of a

car. Many accidents are caused in this way, from collision with posts or passing vehicles.

Watch for teams and automobiles when you get off a car. Look both ways.

Don't throw banana peels or other things into the street for others to slip on or trip over.

Fig. 141.—The right and the wrong way to get off a car. Which is which?

Remember that sling shots, air guns, and "beebee" guns are dangerous, and that the throwing of sand or stones may cause serious injury.

Keep away from excavations and open manholes.

Let strange dogs alone.

Safety from Wires.—To handle wires of any kind, hanging from poles or trees, or to tamper with them may cause a serious accident or death. They may be live wires; that is, an electric current may be passing through them.

Report broken wires to the Police Department by telephone immediately.

Do not fly a kite near wires.

Do not throw stones or shoot at the glass insulators on the poles.

Do not throw strings or wires over a trolley or other wire carrying an electric current.

Safety on Railroad Tracks and in Railroad Yards.—It is dangerous to play along railroad tracks or on railroad bridges. Trains may be expected at any time.

Keep out of railroad yards.

Keep off the sidings and cars standing on tracks.

When crossing railroad tracks, stop and listen; look in both directions. A bell ringing or a moving signal arm indicates that a train is approaching.

Never crawl under or through a standing train. It may start when you least expect it.

To walk around lowered gates or crawl under them is dangerous.

Safety in the Factory or Shop.—Modern industry requires swiftly-moving machinery. It makes necessary the handling of heavy materials and the carrying out of dangerous processes. Many of the children now in school will soon be working in these factories, and if they remember about SAFETY FIRST, many sad accidents may be prevented.

Remember that moving machinery of all kinds is dangerous. No one should go near such machinery until he has learned just what the special danger points are and how they can be avoided. All gears and other moving parts, unless covered by safety guards, are exceedingly dangerous.

Remember that

Shafting, belts, and pulleys are dangerous. Keep away from them.

Elevators and elevator shafts are dangerous.

Open holes and pits in the factory or elsewhere are dangerous.

Slippery floors often cause severe falls.

Carelessly-placed ladders may tip over and injure many people.

Piled-up heavy material is dangerous. A piece may slip and cause the whole to topple over.

Flying particles of steel and other bodies may cause blindness.

Nails and splinters left about may stick into some one and cause blood poisoning.

Safety from Firearms.—Firearms are always dangerous. They are made to kill, and children should never be allowed to play with them. A gun or a pistol should never be pointed at any one. You can never be sure that it is not loaded.

Safety on the Water.—The best way to avoid the danger of drowning is to learn to swim. This is one of the things every child should know, for his own life and the lives of others may some time depend on it.

A swimmer, however, should never be reckless. He should not swim out too far, or go in swimming without some help near by. Even the most expert swimmer may be taken with a cramp and need instant assistance.

Never play in a rowboat or canoe. Don't rock it and do not try to stand up or change seats when a boat is in deep water. Do not lean over the side, or make sharp sudden movements.

In case you are thrown into deep water by the turning over of a boat, or from any other cause, try to keep your presence of mind, even if you cannot swim. Remember that the water will almost support your weight. You can

allow yourself to sink so that your nose is just above the water, and support yourself by a hand on the boat; or an oar under the chin will hold you up. If you are unable to catch hold of anything to help support you, lie flat on your

Fig. 142.—The child who has learned to swim has formed an admirable hygienic habit, which may some day enable him to save his life or that of some one else.

back with your arms stretched out. With light clothing, one may float almost indefinitely in this position, especially in salt water. Do not become excited if the water or spray rises momentarily over your face. Above all, do not attempt to throw up your head or, still worse, your arms or legs, as this will cause the body to sink.

Questions for Discussion and Review

1. Can you give an example of a person's risking his life recklessly, just to show that he is not afraid?

2. What difference is there between the reckless endangering of life and the risking of life to save another or to serve a cause? To which does the modern slogan Safety First apply?

3. What three things do we learn by this slogan?

4. Do you recall any careless act of the past day or week that had ill consequences? Any act that might have had grave results?

5. What are some of the things that you can do to make your own home safe?

6. What are some of the habits that cause street accidents?

7. How should you get on and off a street car? Explain.

8. Sand fights are very popular among children at the seashore. Why are they not safe?

9. During a cyclone in a western city, the lighting system was seriously damaged. People were obliged to carry lanterns, in going about the dark streets. The police were constantly warning them to look out for live wires. What did they mean?

10. Why do railroads warn the public against trespassing on railroad property?

11. What are some of the conditions that cause accidents in factories?

12. If there is a factory in your town, try to find out what steps are taken to guard against injury to the workers.

13. What is your opinion of a "safe and sane Fourth"? Suggest ways of celebrating the day more suitably than the old-fashioned way.

14. What do you think of the rule that is in force in most summer camps for boys and girls,—that no one shall go on a canoe trip who cannot swim?

15. In water accidents, sometimes the best and strongest swimmers are lost. How can you account for this?

16. Give examples of how a cool head in an accident may avert disaster.

CHAPTER XXXII

SPORT AND HEALTH

BY WALTER CAMP

Health and Strength.—When we speak of a "red-blooded boy," the general interpretation of the phrase means a boy who is well and strong, who does his work and who enjoys his sport to the full. We have reason for this, for, as you have learned in this book, the blood which comes to the heart from the lungs, with its life-giving oxygen, is bright red.

When we speak of a "thoroughbred" boy, again we know what is meant. We know that he is a boy who is like the thoroughbred horse, high-spirited, plucky, courageous, and strong.

Every boy wants to be the type that is described by these expressions, and to keep fit he follows the precepts of health and morality. Every boy is anxious to stand well with his fellows, to be an aid to his team in sports, to be an individual champion, to play fair and to play well. These things are possible under a course of care and self-discipline, and are not difficult of attainment by anyone.

Girls, too, want to be well and strong, and want to be thoroughbred. The boy's life is often more strenuous than the girl's, but her attention to health is, for this reason, even more important.

Anyone who wishes to excel, soon finds that he has taken on a contract which involves patience, persistence, self-

control, and hard work. No boy or girl ever became a leader in sports, or a leader in life, without doing a great deal of hard work, and work which sometimes seemed drudgery. No one ever comes to the top without making certain sacrifices, just as a team in training must give up some of the things they care about in order to accomplish the results they want. It is not an easy road, but it is an eminently satisfactory road and leads to the end desired. For this reason, I am giving something of the detail of the things one must do in order to reach this successful goal.

The Care of the Body.—In the first place, we should remember that the care of the body is one of the most essential things, not only for future development as an athlete, but also for the preservation of general health and condition. The boy does not usually think of this latter part in ordinary times, nor does the girl; but our experience in the World War forced home upon us the necessity of having strong and well men and women. Boys know now that there were hundreds of their fellows, only a few years older, who desired in the most whole-souled way to get into the work of preserving their nation, but were rejected on account of their physical condition.

The three great elements that, in addition to exercise, tend most strongly towards making a boy or girl fit are fresh air, water, and sunshine. Outdoor athletics are to be preferred to indoor; windows should be open in sleeping rooms; and water should be used freely, both externally and internally. Begin the day with a cold bath and rub-down, careful cleaning of the teeth, and a short modern set-up exercise to stretch and supple the muscles and to give a good carriage of the body. At the end of this chapter

we print a "set-up" that has been used most successfully in naval stations and aviation fields and in many schools.

Some Rules for Healthy Living.—After finishing the morning rubdown, take before dressing two glasses of water, not iced but of a temperature of about 60 to 65 degrees, which is cold enough. A boy who is exercising or who is in training should drink seven or eight glasses of water a day. On account of the fact that ice water is usually served at meals, it is well to drink three-quarters of this amount between meals, and not pour down a lot of iced liquid with the food.

Breakfast should not be eaten in a rush, but a proper amount of time allowed for it. An athlete must never eat when tired and exhausted, but should first rest for a certain period. He should avoid violent exercise within an hour after a hearty meal. For the athlete, tobacco and alcohol are also forbidden.

It is well to dress lightly for exercise, but after exercising, while still warm, we should be careful about covering up, putting on a coat in order to escape a sudden chill.

The shoes should be well fitting, for tight shoes or shoes that do not fit the feet make serious trouble. A good circulation is an essential for the athlete, and for health in general. Loose clothes and loose gloves give much more protection from the cold than tight ones. Whenever there is pressure on the hand that impedes the circulation, it tends inevitably to cold hands and, under certain kinds of exposure, may mean frozen fingers. Tight collars not infrequently produce headaches. Wearing tight shoes while sitting outdoors at football games in cold weather may very likely lead to a cold.

Every boy and girl should get nine hours' sleep, and even

ten will do no harm. Nature requires this sleep when the boy is at this age, not only for the purpose of repairing the waste—so that the boy may rest after he has done physical work or has exercised himself in play—but it is also needed to help his growth. Any young person deprived of sleep regularly will be affected in physical progress.

It is worth while, also, to pay particular attention to the eyes. We know a great deal more about the eyes than we used to, and the oculist is now able to repair defects in vision, or to prevent their growing worse, if they are taken in time. Many an athlete has found that it was defective vision that interfered with his ability in sports. The eye is a very strong organ and will stand a great deal; but it has its limitations, and eyestrain is apt to result in headaches and a poor general condition.

Good Sportsmanship.—There are three attributes which a boy should most assiduously cultivate if he wishes to succeed in athletic sports. They are pluck, energy, and perseverance. He should be courageous and should not mind the occasional hurt. He should be able to go on, putting the pain behind him. As for energy, it is the dynamo in the human machine. It is this quality that the coach is looking for in his pupils. Finally, perseverance is an absolute essential. Some boys learn more easily than others. It often happens, however, that the boy who learns too quickly and too easily has not the patience and persistence to go on improving, whereas the boy who has to work harder to get the first start has acquired a power of perseverance which makes him keep on improving. Such boys often make more successful athletes in the long run than those to whom the accomplishment comes more readily.

Every boy should remember the great basis of the sportsman's code: "Fair play and no favor and may the best man win." He should do the best he can at all times. He should never lose courage. He should go through with the job. He should not whimper over a defeat, but rather let it stimulate him to more practice, more care, and more effort, in order to make victory possible the next time.

Importance of Training.—There are many ways by which a boy can improve himself physically. His sports and play have the effect of keeping him in good general condition, provided he follows the other principles already laid down in this chapter. But there is something more that he can do and which will most assuredly count in the long run.

Every boy knows that in football, baseball, and other sports there are certain parts that perhaps seem like drudgery. In football, for instance, falling on the ball, tackling the dummy, running around the field for exercise, and other similar things are like the scales which one must practice on the piano in order to become an accomplished musician. There are certain things that are simple in themselves but which gradually lead to the building up of the successful athlete. One of these is calisthenics. I do not mean the old-fashioned arm and leg work, but a more modern form which tends to make a boy supple, to produce quick coördination between brain and muscle, to make it possible for a boy to work in different positions instead of being dependent upon only one line, and, in general, to make every part of his body active and efficient.

I would not urge a boy to go through the course that some of us went through in the way of "gym work," because I realize fully that it is a bore and that a great deal

of it at that time did no good. But what I am advocating is a far simpler form that takes only ten or fifteen minutes daily and is intended to be directly related to athletic sports. Instead of interfering with a boy's athletics and taking the time which he would like to spend in play, this new form is merely an adjunct to his sports. It is intended to supplement them in exactly the way that is needed, so that he will be more available material for the coach and a more promising candidate for the team. At the same time, this new form of exercise will give him a better chance to continue to enjoy his sports and to gain benefit from them throughout his life. As a boy always likes to know "why," I am giving some of the reasons for this new form of daily "set-up" work.

Principles of Modern Set-up Exercises.—We ought to have effective, short, and really modern setting-up exercises as a supplement to sports. The most vital point is that the setting-up exercises should not "take it out of the men." Because they exhausted energy, setting-up exercises used to be shirked, and the leaders were unable to detect the shirking. Boys went through the motions but slacked the real work. If we find a boy exhilarated and eager to work at the end of his setting-up exercises, we have accomplished far more than if we tired him, or exhausted any of his store of vitality, in a kind of work which should, after all, be merely preparatory.

If, in addition to this, we can reduce the amount of time occupied in these setting-up exercises and still obtain results, we have saved that much more time for other work and play. All the former systems tended to take a longer period of time than was necessary to accomplish the desired results, and over-developed certain muscles in the boys who

practiced them. Bolin, the authority for years on Swedish movements, finally determined that certain of the exercises were almost a waste of time, because they gave exercise to parts that were pretty thoroughly exercised in the ordinary daily work of the boys.

Another point of equal importance is that the setting-up exercises should be made as simple as possible, not only for the boys, but also for the leader. To spend a considerable period of time in teaching the leader so that he can handle setting-up exercises, makes it difficult to secure a sufficient number of trained leaders. If, therefore, we can make this leadership so simple that a long course of instruction in it will not be necessary, and boys will be able to learn it easily, we can save a very material amount of time.

Another reason for a simpler form of setting-up exercises is that the old systems made an extraordinarily wide variation of effort between heavy and light boys. The light boys in some of these cases would get only a small amount of muscular effort, where a heavy boy would get, in the same length of time, under the same exercise, far more than he could comfortably stand. It has been found in sports and games that over-developed biceps, startling pectoral muscles, and tremendously muscled legs are a disadvantage rather than an advantage. The real essential is, after all, as a boy realizes about a motor car, the *engine*. It is the part under the hood as it were—the lungs, heart and trunk—that are most important.

Many trainers of athletes became convinced some time ago of the uselessness of the things that had been regarded as cardinal points in setting-up exercises. It was this that made the captains and coaches, as well as the boys themselves, look with considerable suspicion upon the gym-

nasium-made candidate with big biceps and large knots of muscles. It was found that, outside of weight lifting, immoderate "chinning," or apparently great strength on the parallel bars, these boys were not so valuable as the less muscled, more supple boys. To put it briefly: it was found, in actual practice, that it was "what was under the ribs" rather than what lay over them that was of value. If we give a boy endurance and suppleness, he becomes more able in his sports, more available for his country in time of need, and, in the long run, a more healthy and more valuable citizen.

So I would urge, in giving this simple and modern form of "set-up," that every boy take his "Daily Dozen," either in a group or by himself. I can promise that it will aid him not only to be well and strong, but also to make of himself better material for all his sports and games.

THE DAILY DOZEN SET-UP

The "Daily Dozen Set-up" consists of twelve exercises which, for ease in memorizing, are divided into four groups of three exercises each. Each exercise or movement is given a name, and the names of all the movements of a group commence with the same letter, thus:

I	II	III	IV
1. HANDS	4. GRIND	7. CRAWL	10. WAVE
2. HIPS	5. GRATE	8. CURL	11. WEAVE
3. HEAD	6. GRASP	9. CROUCH	12. WING

These exercises are not difficult or exhausting, and do not demand great strength for proper execution. They are designed, both from a scientific and a practical point of view, to give exactly the right amount of exercise to

every muscle of the body. They are intended to promote suppleness and especially to strengthen those muscles which are seldom brought into play in ordinary daily life. A conscientious fifteen minutes a day with the "Daily Dozen Set-Up" will soon do more for a boy than any amount of skilful physical feats or "strong-man stunts." When one first practices these movements, their effect will be felt on the little-used muscles of the neck, back, and stomach; yet they will not leave the pronounced muscular fatigue which follows the ordinary exercises, and which is of more harm than good.

Any setting-up exercises should be preparatory; that is, they should make the boy ready for the serious work or play of his day, and in no way exhaust any portion of his vitality. This modern "short-hand" method of setting-up leaves boys in an exhilarated condition and, instead of taking anything out of them, prepares the body for any kind of work that is required either of mind or of muscle.

THE POSITION OF REST OR CROSS

Each exercise starts from the position of *Rest* or *Cross*.

1. Heels on the same line, and about three inches apart.
2. Feet pointing forward in nearly a straight line parallel to each other.
3. Knees straight without stiffness.
4. Body erect on hips, inclined a little forward; shoulders square and falling equally.
5. Arms and hands hanging naturally, backs of the hands outward; thumbs along the seams of the trousers; elbows near the body.
6. Head erect and straight to the front, chin slightly drawn in without constraint, eyes straight to the front.

The leader takes a position facing the boys, who should

be so placed as to give ample room for unhampered movement.

Each movement should be executed in time with the orders or counting of the leader, which should (with the exception of the Speed Test) be slow and measured. These exercises do not depend upon snap for their effect upon steady, deliberate strain of the muscles. Any tendency towards hurried, careless execution should be immediately discouraged by the leader, who should, at all times, insist upon uniformity of movement.

In the following instructions, the preparatory commands are in capitals, thus: ORDER. The commands of execution are in italics, thus: *Hands.* Explanation of each movement is given in parentheses.

GROUP I

PRELIMINARY EXERCISES

1. **HANDS**

HANDS: READY: *cross.* (At *cross,* arms are extended laterally and horizontally, palms down. See Fig. I.)

ORDER: *hands.* (At *hands*, the arms are brought back to a position of Attention close to the sides. See Fig. I. **Especial care should be taken to see that whenever, throughout the exercises, this position is taken —as at the completion of each exercise— full control is retained over the arms, and**

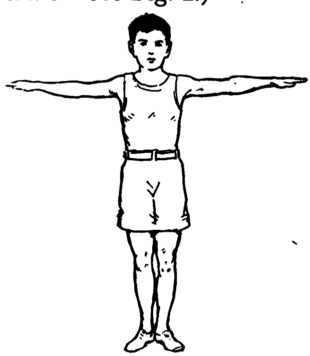

Fig. I.

the hands should not be allowed to slap against the sides audibly.)

ORDER: *rest.* (At *rest,* always return to the position of *cross.* In this case there would be no change).

2. HIPS

HIPS: READY: *cross.*

ORDER: hips. (At *hips,* the hands are placed on the hips with shoulders, elbows, and thumbs well back. See Fig. II.)

ORDER: *rest.*

3. HEAD

HEAD: READY: *cross.*

ORDER: *head.* (At *head,* the hands are placed behind the neck, index-fingertips just touching, and elbows forced back. See Fig. III.)

ORDER: *rest.*

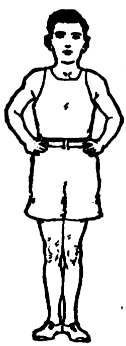

Fig. II.

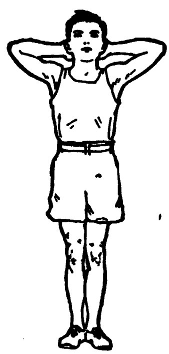

Fig. III.

This first group should have a leader. The other three groups are described so that the boy or girl may go through without a leader.

These exercises should be executed but a few times each, being preparatory to the Speed Test.

Speed Test

In this test, the preparatory command, ORDER, is omitted and the leader gives the commands, *Heads*, *hips*, *hands*, etc., in sharp succession, varying them, and occasionally repeating a command in a manner calculated to catch the unwary napping.

The length of time devoted to this movement is left to the discretion of the leader.

SPEED TEST

SPEED TEST (omitting the word "Order"): ***hands***, ***hips***, ***head***, etc.

ORDER: ***rest.***

GROUP II

4. GRIND

Raise arms sideways to horizontal position. Turn the palms upward and force the arms back as far as possible. While in this position, count *slowly* from one to ten, and at each count describe a complete circle about 12 inches in diameter, the arms remaining stiff, and pivoting from the shoulders. Then reverse the direction of the circle, and do another ten. See Fig. IV.

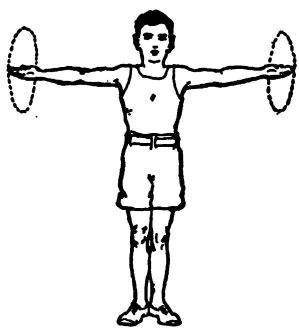

Fig. IV.

5. GRATE

Raise arms, as before, to horizontal. While taking a deep breath, raise the arms to an angle of 45 degrees, and also raise the heels until you are resting on the balls of the feet. Then, while you slowly let out the breath, come back to the original position, feet flat on the floor, arms horizontal. Be careful not

to raise the arms more than 45 degrees, or return them to below horizontal. Do this ten times. See Fig. V.

6. GRASP

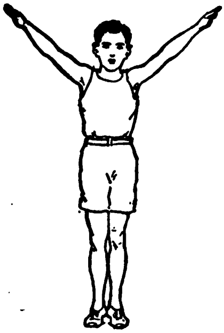
Fig. V.

Raise arms, as before, to horizontal. Place hands behind the head, index fingers touching, elbows forced back. While in this position, bend the body slowly forward from the waist as far as possible. Keep the head up, with the eyes on the leader. Return to upright position, and bend backward a short distance only. Do not make these movements jerky and do not hurry through them. Repeat the whole movement five times, bending forward, then straightening up, then bending backward. See Fig. VI.

GROUP III

7. CRAWL

Raise arms to horizontal. Turn the left palm upward; then raise the left arm and lower the right, until the right is down close to the side, and the left is straight up overhead. Then slowly bend the body sideways to the right from the waist, the right arm slipping down the right leg to or below the knee, and the left arm bending in half a circle downward over the head, until the fingers touch the right ear. Return to original position with arms horizontal, and go down the other way, the left arm slipping along the left leg, the right arm bending downward in half a circle over the left ear. Do this five times. See Fig. VII.

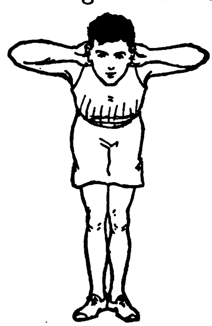
Fig. VI.

8. CURL

EXERCISE A. Raise arms, as before, to horizontal. Move the right foot sideways 12 inches from the left. Slowly close the fists and lower arms downward from the elbows. Then curl the fists upward into the armpits, bending the head backward meanwhile until you look upward at the ceiling. Take a deep breath as you bend the head back. Let the air begin to come out slowly, as you return to the original position, head erect; fists still in the armpits. See Fig. VIII A.

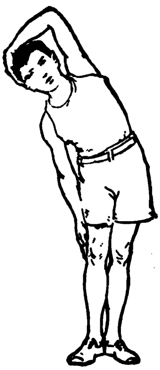

Fig. VII.

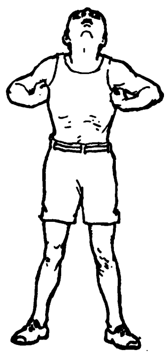

Fig. VIII A.

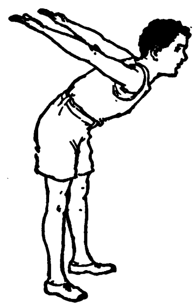

Fig. VIII B.

EXERCISE B. Then, without resting, still letting the breath come out, extend the arms straight forward from the shoulders, palms down. Let the arms begin to fall and the body to bend forward from the waist, head up, eyes to the front, until the body has reached the limit of motion, and the arms have passed the sides and been forced back and up as far as possible. A deep breath should again be taken slowly as you curl your arms, and exhaled as they come down once more.

Do the whole exercises (A and B) five times. See Fig. VIII B.

9. CROUCH

Move the right foot sideways until the heels are about 12 inches apart. Raise arms to horizontal. Rise on the ball of the foot. Bend the knees and, with the weight on the toes, lower the body almost to the heels, keeping the trunk as nearly erect as possible. Return to original position, knees straight,

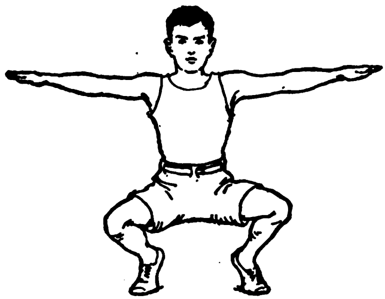

Fig. IX.

Fig. X.

and let the heels go down to the floor. Do this ten times. See Fig. IX.

GROUP IV

10. WAVE

Raise arms as before to horizontal. Stretch the arms straight above the head, fingers interlocked, arms touching ears. Then, with the fingers still interlocked, describe a complete circle about 26 inches in diameter, the body bending only at the waist. Do this five times.

Then repeat the movement five times, but in the opposite direction. Go through the entire movement slowly, and steadily, bending the body in its rotation chiefly from the hips. See Fig. X.

11. WEAVE

Exercise A. Move the right foot until the heels are 12 inches apart. Raise arms to horizontal and turn the body to the left from the hips, the arms remaining horizontal until the face is to the left, the right arm pointing straight forward, and the left arm straight backward. See Fig. XI A.

Exercise B. While in this position, bend the body from the waist, so that the right arm goes down until the right fingers touch the floor midway between the feet, and the left arm

Fig. XI A.

Fig. XI B.

goes up. The right knee must be slightly bent to accomplish this. Return to the original position, body erect, arms horizontal.

Reverse the movement, turning the body to the *right* this time until the left hand points straight forward. Then bend downward until the fingers of the left hand touch the floor. Return to the original position. See Fig. XI B.

After you have mastered the exercise, you can go through it (A and B) in one continuous motion.

Repeat the whole exercise (A and B), first to the right, then to the left, ten times.

12. WING

Raise arms to horizontal, taking in a slow breath; then upward until they are straight overhead. Let them fall forward and downward, while the body bends forward from the waist, until the arms have passed the sides, and been forced upward and backward as far as possible, just as in Exercise 8, Fig. VIII B. Remember, as you bend forward, to keep the head up, and the eyes to the front and let the breath come out.

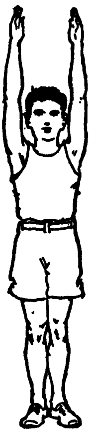

Fig. XII.

Straighten the body upright again, with the arms overhead, drawing in the breath. Lower the arms to the horizontal position, with the palms turned downward, and the arms and shoulders forced hard back. Then bring the arms out to horizontal, and begin the movement again by raising them as before.

Repeat this entire movement slowly five times, forcing the air out of the lungs as the body bends forward, and filling the lungs again as the body straightens. See Fig. XII.

APPENDIX

WEIGHT AND ITS RELATION TO HEALTH

The Child Health Organization of America, with the hearty approval of the Division of School Hygiene of the United States Bureau of Education, is carrying on a nation-wide campaign for the regular weighing of all school children as the basis for a systematic attempt to build up the health of those who are below normal. The aim of this movement is to get "a scale in every school" and to have all the children weighed once each month during the school year. The weights should be entered on a card hung in the classroom and reports sent home at the same time to the parents.[1] Children who are much below the normal weights in the tables, pages 384, 385,[2] should be examined carefully by the school physician or the family physician. By medical treatment when necessary, but more often by improvements in diet or other measures of personal hygiene, they can be helped to reach an ideal standard of health and vigor. All of the millions of school children of America should be enlisted in this great game of building up the strength of the men and women of to-morrow.

[1] Record charts and literature may be obtained from the Department of Documents, Washington, D. C.

[2] Prepared by Dr. Thomas D. Wood; and Copyright, 1918, by Child Health Organization.

HEIGHT AND WEIGHT TABLE FOR GIRLS

Height Inches	5 Yr.	6 Yr.	7 Yr.	8 Yr.	9 Yr.	10 Yr.	11 Yr.	12 Yr.	13 Yr.	14 Yr.	15 Yr.	16 Yr.	17 Yr.	18 Yr.
39	34	35	36											
40	36	37	38											
41	38	39	40											
42	40	41	42	43										
43	42	42	43	44										
44	44	45	45	46										
45	46	47	47	48	49									
46	48	48	49	50	51									
47		49	50	51	52	53								
48		51	52	53	54	55	56							
49		53	54	55	56	57	58							
50			56	57	58	59	60	61						
51			59	60	61	62	63	64						
52			62	63	64	65	66	67						
53				66	67	68	68	69	70					
54				68	69	70	71	72	73					
55					72	73	74	75	76	77				
56					76	77	78	79	80	81				
57						81	82	83	84	85	86			
58						85	86	87	88	89	90	91		
59						89	90	91	93	94	95	96	98	
60							94	95	97	99	100	102	104	106
61							99	101	102	104	106	108	109	111
62							104	106	107	109	111	113	114	115
63							109	111	112	113	115	117	118	119
64								115	117	118	119	120	121	122
65								117	119	120	122	123	124	125
66								119	121	122	124	126	127	128
67									124	126	127	128	129	130
68									126	128	130	132	133	134
69									129	131	133	135	136	137
70										134	136	138	139	140
71										138	140	142	143	140
72											145	147	148	149

About What a GIRL Should Gain Each Month

Age: 5 to 8........ 6 oz.
8 to 11........ 8 oz.
11 to 14........12 oz.
14 to 16.........8 oz.
16 to 18.........4 oz.

HEIGHT AND WEIGHT TABLE FOR BOYS

Height Inches	5 Yr.	6 Yr.	7 Yr.	8 Yr.	9 Yr.	10 Yr.	11 Yr.	12 Yr.	13 Yr.	14 Yr.	15 Yr.	16 Yr.	17 Yr.	18 Yr.
39	35	36	37											
40	37	38	39											
41	39	40	41											
42	41	42	43	44										
43	43	44	45	46										
44	45	46	46	47										
45	47	47	48	48	49									
46	48	49	50	50	51									
47		51	52	52	53	54								
48		53	54	55	55	56	57							
49		55	56	57	58	58	59							
50			58	59	60	60	61	62						
51			60	61	62	63	64	65						
52			62	63	64	65	67	68						
53				66	67	68	69	70	71					
54				69	70	71	72	73	74					
55					77	74	75	76	77	78				
56					77	78	79	80	81	82				
57						81	82	83	84	85	86			
58						84	85	85	87	88	90	91		
59						87	88	89	90	92	94	96	97	
60						91	92	93	94	97	99	101	102	
61							95	97	99	102	104	106	108	110
62							100	102	104	106	109	111	113	116
63							105	107	109	111	114	115	117	119
64								113	115	117	118	119	120	122
65									120	122	123	124	125	126
66									125	126	127	128	129	130
67									130	130	132	133	134	135
68									134	135	136	137	138	139
69									138	139	140	141	142	143
70										142	144	145	146	147
71										147	149	150	151	152
72										152	154	155	156	157

About What a BOY Should Gain Each Month

Age: 5 to 8.........6 oz. 12 to 16........16 oz.
8 to 12.........8 oz. 16 to 18........ 8 oz.

HOW TO MAKE A FLYTRAP[1]

The Size of the Trap.—The conical hoop trap consists essentially of a screen cylinder with a frame made of barrel hoops, in the bottom of which is inserted a screen cone. The height of the cylinder is 24 inches, the diameter 18 inches, and the cone is 22 inches high and 18 inches diameter at the base.

Materials.—Material necessary for this trap consists of

Four new or secondhand wooden barrel hoops.

One barrel head.

Four laths.

10 feet of strips 1 to 1½ inches wide by ½ inch thick (portions of old boxes will suffice).

61 linear inches of 12 or 14 mesh galvanized screening 24 inches wide for the sides of the trap, and 41 inches of screening 26 inches wide for the cone and the door.

An ounce of carpet tacks.

Two turn-buttons, which may be made of wood.

The total cost of the material for this trap, if all is bought new at retail prices, is about 65 cents. In practically all cases, however, the barrel hoops, barrel head, lath, and strips can be obtained without expense. This would reduce the cost to that of the wire and tacks, which would be 45 cents. If a larger number of traps are constructed at one time, the cost is considerably reduced.

[1] From *Flytraps and their Operation*, Farmers Bulletin 734, issued by the Department of Agriculture.

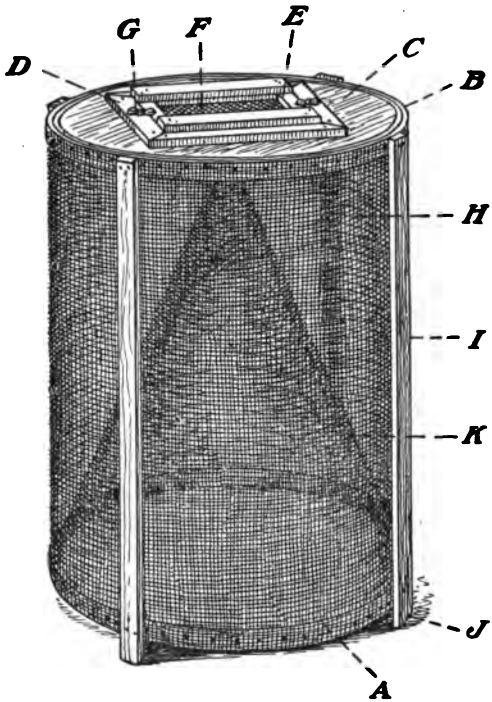

Fig. 143.—Conical hoop flytrap. A. Hoops forming frame at bottom. B. Hoops forming frame at top. C. Top of trap made of barrel head. D. Strips around door. E. Door frame. F. Screen on door. G. Button holding door. H. Screen on outside of trap. I. Strip on side of trap between hoops. J. Tip of the strip projecting to form leg. K. Cone.

Construction of the Trap.—One of these traps is illustrated in Fig. 143. In constructing the trap, two of the hoops are bent in a circle (18 inches in diameter on the inside), and nailed together, the ends being trimmed to give a close fit. These form the bottom of the frame,

and the other two, prepared in a similar way, form the top.

The top of the trap (Fig. 144) is made of an ordinary barrel head with the bevel edge sawed off sufficiently to cause the head to fit closely in the hoops and allow secure nailing. A square, 10 inches on the side, is cut out of the center of the top to form a door.

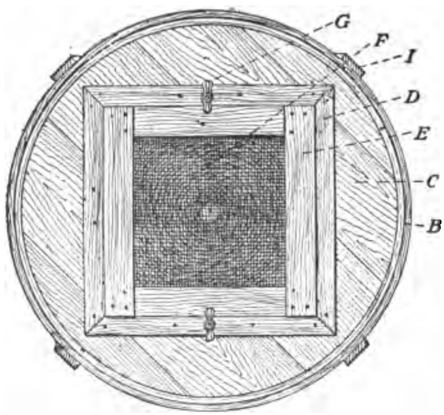

Fig. 144.—Top view of conical hoop flytrap. Letters designate parts, as in Fig. 143.

The portions of the top (barrel head) are held together by inch strips (D) placed around the opening ½ inch from the edge to form a jamb for the door. The door consists of a narrow frame (E) covered with screen (F), well fitted to the trap and held in place (not hinged) by buttons (G).

The top is then nailed in the upper hoops, and the sides are formed by tacking screen wire closely on the outside of the hoops. Four laths (or light strips) are nailed to the hoops on the outside of the trap to act as supports between the hoops, and the ends are allowed to project 1 inch at the bottom to form legs.

The cone is cut from the screen, and either sewed with fine wire or soldered where the edges meet. The apex of the cone is cut off to give an aperture 1 inch in diameter. The

cone is then inserted in the trap and closely tacked to the hoop around the base.

Construction of the Cone.—The construction of a cone of given height or diameter is quite simple if the following method is followed. It is best to cut a pattern from a large piece of heavy paper, cardboard, or tin. Fig. 145 illustrates the method of laying out a cone of the proper dimensions for the above trap.

An ordinary square is placed on the material from which the pattern is to be cut. A distance (22 inches) equal to the height of the cone is laid off on one leg of the square at A, and a distance (9 inches) equal to one half of the diameter of the base of the cone is laid off on the other leg at B. A line is then drawn between the points A and B.

With the distance between these points as a radius and with the point A as a center, the portion of a circle C D is drawn. With a pair of dividers, the legs of which are set 1 inch apart, or with the square, lay off as many inches on the arc C D, starting at C, as there are inches around the base of the cone—in this case about 56½ inches, reaching nearly to the point E. Then add ½ inch for the lapping of the edges of the cone, and ½ inch which is taken up when the cone is tacked in, thus making a total distance from C to E of 57½ inches. Draw a line from A to C and another from A to E, and cut out the pattern on these lines and on the arc from C to E, as shown in Fig. 145. The edges A C and A E are then brought together, lapped ½ inch, and sewed with wire or soldered.

After the aperture of the cone is formed by cutting off the apex, as previously described, it is ready for insertion in the trap.

In order to figure the distance around the base of a cone

of any given diameter, multiply the diameter by 3.1416 or $3^1/_7$.

The height of the legs of the trap, the height of the cone, and the size of the aperture in the top of the cone, each are of importance in securing the greatest efficiency.

The Bait for the Trap.—The trap may be baited with milk or a mixture of water and molasses that has been

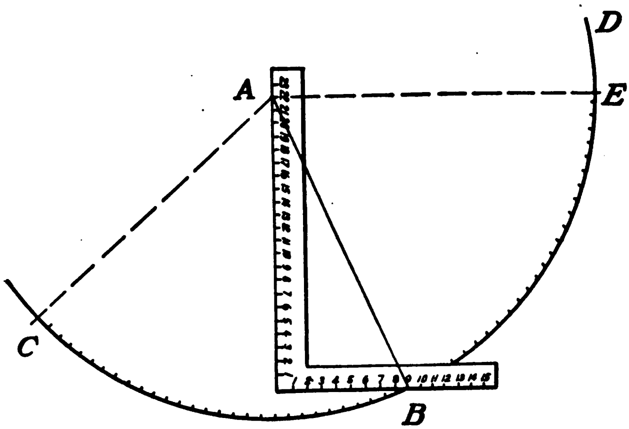

Fig. 145.—Method of laying out a pattern for the construction of a cone. Cut out on curved line C to E and on dotted lines from A to C and A to E.

allowed to ferment. Crushed overripe fruit is also effective, especially if combined with milk. The water and molasses mixture should not be used if there are honey bees near by, since it attracts them in great numbers.

The bait should be placed in a shallow pan about four inches smaller in diameter than the bottom of the trap. The pan is set upon the ground under the cone; the flies rising from the bait pass through the hole at the top of the cone and into the trap.

TABLE OF FOOD VALUES [1]

The weight (in ounces and rough measure) of a portion containing 100 calories and the per cent of protein, fat, and carbohydrates in each food.

NAME OF FOOD	PORTION CONTAINING 100 CALORIES ROUGHLY DESCRIBED	WEIGHT OF 100 CALORIES IN OUNCES	PER CENT OF		
			PROTEIN	FAT	CARBOHYDRATE
VEGETABLES					
Asparagus, as purchased, average, canned	....	19.	33	5	62
Beans, baked, canned	Small side dish	2.66	21	18	61
Beans, string, cooked	Five servings	16.66	15	48	37
Cabbage, edible portion	....	17.	20	8	72
Celery, edible portion, average	....	19.	24	5	71
Corn, sweet, cooked	One side dish	3.5	13	10	77
Cucumbers, edible portion, average	....	20.	18	10	72
Lettuce, edible portion, average	....	18.	25	14	61
Peas, green, cooked	One serving	3.	23	27	50
Potatoes, boiled	One large-sized	3.62	11	1	88
Tomatoes, fresh, as purchased, average	Four average tomatoes	15.	15	16	69

[1] Based on Tables in Fisher and Fisk's *How to Live;* used by permission of the authors.

Name of Food	Portion Containing 100 Calories Roughly Described	Weight of 100 Calories in Ounces	Per Cent of		
			Protein	Fat	Carbohydrate
Fruits					
Apples, as purchased..	Two apples......	7.3	3	7	90
Bananas, yellow, edible portion, average....	One large........	3.5	5	5	90
Cantaloupe..........	Half ordinary serving...........	8.6	6	0	94
Cooked Meats					
Beef, round, boiled (lean)............	Large serving.....	2.2	90	10	00
Lamb chops, boiled, edible portion, average...............	One small chop..	.96	24	76	00
Cake, Pastry, Pudding					
Cake, chocolate layer, as purchased.......	Half ordinary square piece ...	.98	7	22	71
Custard, caramel.....	....	2.51	19	10	71
Pie, apple, as purchased	One third ordinary piece..........	1.3	5	32	63
Pudding, apple tapioca	Small serving.....	2.8	1	1	98
Cereals					
Bread, corn (johnny-cake) as purchased, average...........	Small square.....	1.3	12	16	72
Bread, white, home made, as purchased.	Ordinary thick slice..........	1.3	13	6	81
Crackers, graham, as purchased.........	Two crackers.....	.82	9	20	71
Oatmeal, average, boiled.............	One and a half serving........	5.6	18	7	75

Name of Food	Portion Containing 100 Calories Roughly Described	Weight of 100 Calories in Ounces	Per Cent of		
			Protein	Fat	Carbohydrate
Cereals					
Rice, boiled, average..	Ordinary cereal dish..........	3.1	10	1	89
Rolls, Vienna, as purchased, average.....	One large roll.....	1.2	12	7	81
Dairy Products					
Butter, as purchased..	Ordinary pat or ball..........	.44	.5	99.5	00
Cheese, American, pale, as purchased......	One and a half cubic inch.........	.77	25	73	2
Milk, whole, as purchased............	Small glass.......	4.9	19	52	29
Sweets, Nuts, Miscellaneous					
Marmalade (orange peel)..............	....	1.	.5	2.5	97
Peanuts, edible portion, average.......	Thirteen double ..	.62	20	63	17
Eggs, hen's, boiled....	One large egg.....	2.1	32	68	00
Omelet..............	....	3.3	34	60	6
Soup, bean, as purchased, average.....	Very large plate..	5.4	20	20	60
Consomme, as purchased............	....	29.	85	00	15

ESTIMATED WHOLESALE COST OF THE RAW MATERIALS IN CERTAIN STANDARD FOODS. AMOUNTS NECESSARY TO YIELD 2500 CALORIES ARRANGED ACCORDING TO THEIR INCREASING COST[1]

Apple tapioca pudding	$.04
Rice, boiled	.04
Bath buns	.06
Pie, apple	.07
Pie, rhubarb	.08
Apple, baked	.09
Pie, strawberry	.09
Cocoa	.09
Crullers	.10
* Fish cakes with tomato sauce	.13
Muffins, corn	.13
* Lamb croquette and mashed potatoes	.14
* Beans, Boston baked	.15
* Beef, corned	.15
Pie, lemon	.15
Chicken wings on toast	.16
Napoleon	.16
* Salad, potato	.16
Toast, buttered	.16
Cream roll	.17
* Beef, creamed, chipped on toast	.18
Cakes, butter	.19
* Roast, Vienna, and spaghetti and potatoes	.19
Pudding, tapioca, creamed	.20
Sandwich, oyster	.20
* Veal cutlet, breaded and tomato sauce	.20
* Beef, corned, hash browned in pan	.21

[1] See note on page 376.

* Liver and bacon	$.21
* Roast, Vienna, with French fried potatoes	.21
* Stew, lamb	.21
* Beans, New York, baked	.22
Cakes, buckwheat, with maple cane sirup	.22
Coffee, cup of (contained cream and sugar)	.22
Pudding, bread, with vanilla sauce	.24
* Beef, corned, hashed, steamed	.25
Oatmeal, fresh cooked, with cream	.25
* Stew, beef	.25
Pie, oyster	.26
Potatoes, French fried, extra order	.26
* Sandwich, ham	.26
* Beef, creamed, chipped	.27
* Sandwich, corned beef	.27
* Beef, corned, hashed, steamed, with poached egg	.28
* Mackerel, broiled salt, with mashed potatoes	.28
Milk	.29
Pudding, rice, cold	.29
* Rice, hot, with poached egg	.29
Soup, bean, with croutons	.29
* Sandwich, minced chicken	.30
Cornstarch, chocolate, with cream	.31
Ice cream, strawberry	.31
* Omelet, ham	.32
Sandwich, cream cheese walnut	.32
* Omelet, plain	.33
Cornstarch, vanilla, with cream	.34
* Omelet, onion	.34
* Oyster fry, small	.34
* Eggs, fried	.35
* Sandwich, fried egg	.35
Sausage, country	.35
* Chicken croquette and French fried potatoes	.36
* Eggs, creamed, on toast	.36
* Omelet, parsley	.37
* Omelet, Spanish, with French fried potatoes	.37
* Sandwich, tomato	.39

* Eggs, scrambled	$.40
* Lamb chops	.40
Sandwich, club	.40
* Salad, tuna fish	.41
Custard	.43
* Sandwich, chicken, sliced	.43
* Steak, tenderloin	.43
* Ham, fried	.44
* Sandwich, roast beef, hot	.44
Strawberries with cream	.44
Toast, milk	.45
* Eggs, boiled	.47
* Omelet, chicken	.47
* Sandwich, minced chicken with lettuce	.49
* Eggs, poached on toast	.59
* Shad, baked, and dressing	.61

From Fisher and Fiske's *How to Live;* used by permission of the authors and of Professor Graham Lusk who prepared the original tables. Items marked with an asterisk (*) include an order of bread and butter, which are figured in the food values. The prices are based on investigations made in 1915, and the costs would in many cases be quite different now. The relative values of the different foods would, however, remain practically the same.

A WELL-BALANCED FOOD SUPPLY

The following well-balanced and economical diet list for a typical family of five persons has been prepared by the Department of Public Health of the American Museum of Natural History.

Note that grain products, such as bread and cereals, form the cheapest source of calories. Milk supplies calories, proteins, calcium, and vitamins. Vegetables and fruits furnish salts and vitamins. Meat, fish, and eggs contain valuable proteins.

FOOD SUPPLY FOR A FAMILY OF FIVE FOR ONE WEEK

Kind of Food	Amount in pounds	Cost (Apr. 1922)	Percentage of Total Cost of Food
Meats and fish	5¼	$ .73	7.7
Eggs	¾	.15	1.6
Milk	46 *	2.52	26.5
Cheese	1	.35	3.7
Fats	3½	1.02	10.7
Sugar	4	.24	2.5
Grain products (bread, cereals, etc.)	19⅛	1.29	13.6
Vegetables	25½	1.43	15.1
Fruits	8¾	1.63	17.2
Nuts (including peanut butter	½	.10	1.1
Coffee	½	.07	.7
Total Cost		$9.53	

* 46 pounds of milk amounts to 21 quarts.

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A star (*) after a page number indicates an illustration.